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A New Form of Trade Union.

Some time ago we referred briefly to a form of trade organization or alliance devised by E. J. Smith, of Birmingham, England, and first applied successfully to the metallic bedstead trade of that city. In the January number of "The Forum" Mr. Smith has an article entitled "A Living Profit and a Living Wage," in which he explains at some length what this trade alliance undertakes to do and how it does it. There is much originality in the scheme, although it may fairly be said to be very much like our trusts, with the exception that the workmen are made part of it, and thus their co-operation secured in defending the organization and in fighting any unfair competitor who remains outside of it.

Mr. Smith states that he himself has passed through all stages of industrial life, from apprentice boy to workman, foreman, superintendent, director and proprietor. He was a manufacturer of metal bedsteads, and this trade had become very much demoralized through "savage and unrestrained competition," much of the selling being done at prices that utterly disregarded costs of production, and in fact largely by manufacturers who did not know what their own costs were. Profits for the most part entirely disappeared, although the work people, by means of their unions, were enabled to protect themselves to some extent. The manufacturers had an organization, which met occasionally and passed resolutions "which some of the members intended to carry out." But under the organization "Honest men lost their trade and the unscrupulous secured it."

Finally, after long consideration, a plan proposed by Mr. Smith was adopted, and for about eight years it has worked well, and has been introduced into other lines of manufacture. Its two cardinal principles are stated to be: (1) Selling from well-ascertained cost of production, and (2) co-operating with the workpeople in securing a fair profit.

Prices at which a member may sell his product are in some lines not fixed by the association, and a manufacturer may sell at any price that suits him, but upon being called upon to do so he must show that, at the price, there is, for him, at least a minimum profit previously determined upon as fair, and he must pay to the people who work in his factory the standard wages agreed upon, together with a previously agreed upon bonus based upon profits.

This leaves each manufacturer free to improve his methods as much as he may choose, or he may produce any grade of goods his trade demands, omitting, if he wishes, any process followed by others in the production of more expensive or different goods. In fact, he may, under this plan, do any of the things that unassociated manufacturers are in the habit of doing to secure trade except two things: He cannot sell at a loss, nor in fact at a price that does not afford him a profit, nor pay to his employees less than the agreed upon wages and bonus.

This is the plan followed in the metallic bedstead industry, where a great variety of bedsteads must necessarily be made, differing from each other very much in style and quality, and, of course, intended to be sold at varying prices.

In other industries, however—those in which the product is a standard article and the goods of one factory will sell as readily as those of another—the price is fixed by the association, and no variation from this is allowed except by consent of the association.

A board composed of an equal number of employers and employees decides matters of dispute and makes, or causes to be made, all investigations as to charges of underselling, costs of manufacture, etc., and it has the power to order the forfeiture of a sum of money pledged and guaranteed by each member upon joining the association, such forfeiture being imposable for infidelity to the association.

Just here is where the workmen's part comes in in sustaining the power of the association, for the workmen agree not to help in any way a manufacturer who forfeits his membership or opposes the association, and any workman who does so is disciplined by the workmen's union. On the other hand, workmen have an incentive to render efficient service, because the amount of the bonus they receive depends upon the amount of profit made by the employer, and the association does not restrict the amount of profit that may be made, but only insists that the prices at which a member sells his goods shall afford him at least a minimum rate of profit based upon his costs of production, ascertained by the association's standard method of determining such costs. Each member is compelled to learn how to ascertain what his product costs him.

As Mr. Smith puts it, when speaking of adverse criticism of his plan: "I am glad to have a government that punishes a man who picks my pocket; and I am glad to be a member of any community that will prevent me from being robbed in any other way. Manufacturers must take their choice of two evils—if this kind of coercion may be called an evil—the evil of unrestrained, cut-throat, ruinous and iniquitous underselling, or the system by which it can be prevented. . . . If there is a better way I have not heard of it. Meanwhile, there is not an honest man in any of these combinations who can prove that under any circumstances whatever has he been prevented from doing anything which common sense or an appreciation of common justice would not condemn. If he wishes to trample on justice and to outrage common sense, he is dangerous to society and ought to be restrained. I have already said that 90 per cent. of the members of these combinations are perfectly satisfied. The other 10 per cent. might well be termed

'various;' but they are not all fair-minded men. They have the right to fight for their own hand; but if they are beaten by the majority they may take comfort from the thought that this is the way in which every good nation is governed.

"The principle supplying the necessary power is actual and active co-operation with the workpeople and a recognition of their rights in return for such *help as cannot be obtained from any other source.* There are two causes which have brought about the deplorable state of things among manufacturers to-day—imbecile underselling and labor troubles. The system I advocate prevents labor troubles by preventing underselling. The cure can come only from the power to control, and the power can be gained only by an acknowledgment that the interests of employers and employed are one."

It is readily seen that in case of dull trade or where foreign competition affects the market, employers and employed are able to co-operate understandingly to meet the conditions as they find them, and that the men will readily consent to a lowering of prices and a consequent abatement of the bonuses paid to them, or even to lower wages if necessary, rather than be idle for a portion of the time, and thus suffer loss in that way. And, of course, it is readily seen that such a condition might stimulate improvements designed to lessen cost, and that both employer and employee would naturally favor and facilitate such improvements.

Mr. Smith enumerates the following conditions which result from the alliance:

"1. The workpeople have a guarantee that existing wages shall never be reduced so long as the alliance lasts.

"2. Wages for new articles introduced after its formation may be settled on each works; but either side can call upon the board to fix them.

"3. The first bonus is also a fixture, as selling prices will not be reduced below the first level.

"4. Any further bonus can only be paid on any increased actual profit. Any change in selling prices caused by advance in the prices of material, and not carried beyond, is exempt from further bonus.

"5. All bonuses after the first are subject to a sliding scale whenever real profits are increased or decreased.

"6. No strike or lockout is permitted unless in defense of the alliance. Then it is supported by both sides, and the expenses are divided.

"7. In the event of any dispute to be referred to the board, workmen must accept employers' conditions and prices under protest. They cannot leave their employment or be discharged on account of the dispute; but the settlement must be retroactive, so that no injustice may be done.

"8. Each employer retains full control over his own works upon all matters but those pertaining to wages and bonus and conditions of labor. Workmen can be discharged for any other reason, and are themselves free to change their employment whenever they wish to do so.

"9. The workmen's union must supply a sufficient number of good workpeople, and the board decides as to the necessity or otherwise of bringing new men into the trade.

"10. No restriction is placed upon anyone wishing to come into the trade, so long as he agrees to sell on the lines laid down by the association, and to comply with the rules that govern competitors."

Furthermore—

"*a.* It recognizes that unity is strength, whether among employers or employed.

"*b.* It insists upon employers ascertaining beyond dispute the real cost of production before deciding upon the selling price, which *must* show a fair profit.

"*c.* It acknowledges that if by organization employers are able to obtain a fair profit, it is their duty to pay their employees a fair wage, *which they are compelled to pay.*

"*d.* It welds both sides into a compact body for the mutual purpose of insisting that all concerned shall have justice done to them according to the agreement made, and that both sides shall work together with this object. All this is done by set rules and agreements, accepted on either hand after full consideration of all interests involved."

Mr. Smith recognizes that the consumer ought to be and indeed must be considered and he sums up his side of the question as follows:

"1. The consumer has never yet had the protection of a selling price based on the cost of production ascertained by the wisdom and experience of a whole trade. Under this system he is sure to get it.

"2. Under a trust, or monopoly of any kind, capital alone decides what he shall pay. Under this system the poorest class of consumer, the workman, has a voice in determining the price at which articles shall be sold to himself—and others.

"3. Should unjust selling prices drive away trade, the bonus on wages paid to workpeople will not compensate them for loss of time caused by slackness of trade. They will therefore not consent to unjust selling prices, although these may bring them larger bonuses. Their consent is necessary under the terms of the alliance.

"4. Under this system no restriction is placed upon anyone wishing to enter a trade, excepting that of not selling goods without the right proportion of profit on the cost of production. The result is that the consumer has no impediment in the way of making the goods for himself, should he care to do so."

The editor of "The Forum" announces that a book written by Mr. Smith will soon be ready for publication, and in this, no doubt, his plan will be much more fully set forth. It is certainly well worthy of serious consideration and of something better than mere captious or carping criticism.

One of our contemporaries, commenting upon Mr. Smith's article, remarks: "It has been urged, too, that such a compact for mutual benefit between men and makers might prove a dangerous one to the industry and the country, when the question arises of meeting competition of capital and labor, warring merrily, in other countries;" a criticism which seems to be founded upon the queer idea that capital and labor, when warring with each other, are more efficient and better prepared to meet competition than when they are harmonious and united upon a basis of mutual interest and confidence.

Under ideal industrial and economic conditions no such elaborate plan of self-protection would be necessary; but we do not live under ideal industrial and economic conditions, and many despair of ever obtaining them, and so long as the vast majority of men can manage to keep their heads above water only by the most strenuous and unremitting effort, and so long as economic and industrial conditions are such that some families are in danger of want or starvation simply because men in another part of the world can produce desirable things cheaply—so long as industrial competition is referred to as "war," and the defeated are reduced to want, or perhaps starvation, organizations of some kind will continue to seem imperatively needed; and if they are to continue to be formed, is it not best that they be made as thorough as possible and to include in them every element that can contribute to success? This Mr. Smith evidently endeavors to do, and the degree of success that has resulted thus far entitles his plan to more than passing notice.

The following occurs in a newspaper report of a recent lecture upon the steam engine indicator: "He said that instead of the movement board that was used in the time of Watts a silk drum was used. The indicator card furnishes eyes for the engineer to look inside the boiler. All pressure is faithfully indicated on the card. To ascertain the horse-power of an engine we have to consider the pressure on both sides of the card. The temperature of the steam in a vacuum of 26 inches is 207 degrees."

The National Association of Manufacturers has arranged for a trip to Paris under the management of its Transportation Bureau. It is expected to sail on the "St. Louis" June 13, and to have about nineteen days ashore. The facilities of the association are offered to members, who are requested to communicate with the bureau named above, B21, Produce Exchange, New York, in case they desire to go.

Commercial Review.

NEW YORK, FRIDAY EVENING,
February 9, 1900.

COMMENTS ON FOREIGN TRADE.

The United States Export Association is the title of an organization somewhat resembling in its purpose the National Association of Manufacturers and the Philadelphia Commercial Museum. The headquarters are at 143 Chambers street, New York city, and Mr. F. B. Thurber, prominent in commercial circles, is president. Among the machinery and other firms which are members are the Pratt & Whitney Company, Fifield Tool Company, Long & Allstatter Company, Edwin Harrington, Son & Co., Cleveland Twist Drill Company, Standard Tool Company, Cleveland, Frick Company, H. W. Johns Manufacturing Company, Schulz Belting Company, Jeffrey Manufacturing Company, Otis Elevator Company, Atlas Engine Works, Robert Poole & Son Company, J. A. Fay & Co., Egan Company, Carnegie Steel Company, Bethlehem Steel Company, Crescent Steel Company.

A representative of the "American Machinist" called at the office of the association this week, meeting Mr. Thurber and others, and was accorded an expression of some views on export trade. In regard to foreign credits, reporting upon which is one of the chief functions of the association, the following views were given:

"It is easy to overestimate the magnitude of England as a consumer of American merchandise, since a large proportion of the goods that go there is reshipped from London and Liverpool to other countries. American goods are also reshipped to a considerable extent from Germany to Russia. England and Germany are the most aggressive nations in their foreign trade. They are willing to grant long credits, say from three to six months, and will trust their customers even if not highly capitalized, provided their reputation is good. Americans, as a rule, are much more conservative in their foreign credits, and they lose a great deal of business by this attitude. It would be better policy to offer liberal terms, as do the English and Germans—acting, of course, upon adequate information. Credit laws are more strict in most European countries than in the United States, so that the buyer is under a stronger pressure not to make default in meeting his obligations."

"In agricultural machinery trade," it was remarked, "there are three countries distinctly promising—Russia, Australia and Argentina. The last named is the only really hopeful country in South America for machinery. There is a large direct traffic from the United States to Argentina, passing through its ports Rosario and Buenos Ayres.

"The South African war has caused a sharp falling off of trade in general manufactured goods with that quarter, though the shipments there, as a whole, show a surprisingly small diminution, owing to the demand for provisions and other military supplies. Many orders were canceled because of the war, but some shipments that have been withheld are now going forward.

"Aside from South Africa, there is hardly a market in the world which has not been showing a steady increase through the past."

Consul Heenan writes from Odessa, Russia: "Patience and long credits are absolutely essential in order to do business in Russia. Russia, in a business way, is practically the great unknown. I would like to utter a word of warning to Americans attempting to do an indiscriminate business in this country. Much is published about the great opportunities in this country, but very little is told about the difficulties, losses and embarrassments which are always met with by those who fail to take the proper precautions. In case of failure the home creditors are usually paid, but the foreign ones are not. The fact that we have furnished the Russian Government with millions of dollars' worth of various goods and were paid for the same is gratifying. The Russian Government always pays, but discrimination should be used in dealing with the business element generally."

MISCELLANEOUS.

Indications of dullness in the engine trade are to be found in many offices, though with all things balanced we would not assert that there has been a distinct slump. Some sellers are yet bewailing the fact that their companies are not in any position to accept the contracts that present themselves. One concern last week let orders for ten engines slip by because it could not give sufficiently early deliveries. It needed five or six months, where the customers were willing to wait only about three.

It looks as if values had seen pretty nearly their top limit. While they are strong in some quarters, and an advance has been made by one company within a week or two, there are rumors that other manufacturers are cutting prices. These rumors are so far exceptional as to cause not a little surprise when repeated, nor is it known that they have reference to other than high-speed engines.

An old and well-known American engine company booked orders in 1899 amounting to nearly six times the total in 1897.

The Bass Foundry and Machine Works are erecting a 26 and 52x60-inch cross-compound engine for the Fall River Manufactory, a cotton mill at Fall River, Mass. It will have a flywheel of 24 feet diameter, 120 inches face.

Woolston & Brew have taken orders from the International Paper Company for three 16x24-inch and two 18x24-inch side-crank Fischer four-valve engines, speed about 150 revolutions per minute. They are to be installed in a paper mill at Corinth, N. Y. The same firm has sold a 14x36-inch C. H. Brown & Co. engine for the State prison at Auburn, N. Y., and a 22x48-inch engine of that make to the Montello Clay and Brick Company, Reading, Pa.

Westinghouse, Church, Kerr & Co. have sold another vertical compound engine of 2,500 horse-power for shipment to the Metropolitan Electric Supply Company, of London, England. A 280 horse-power Westinghouse gas engine has been sold to the Great Western Railway Company, England. Three of that size were sold a short time ago to the Metropolitan Railway Carriage and Wagon Company, Birmingham.

The Metropolitan Electric Supply Company has recently ordered four 90-gallon Cross oil filters, manufactured by the Burt Manufacturing Company, of Akron, Ohio. The British Government has also been a large buyer of these appliances during the past year, despite the fact that the English makes are plentiful and cheap.

A dispatch from Easton, Pa., states that the Easton Power Company has ordered $150,000 worth of Westinghouse electrical machinery, and will add an 800 horse-power emergency steam plant.

A financial circular upon the William Cramp & Sons Ship and Engine Building Company, issued by Chandler Bros. & Co., Philadelphia, shows $12,400,000 business on the books at the end of the last fiscal year, ending April 30, 1899, as compared with $10,000,000 at the end of the previous fiscal year. The gross earnings for 1898-99 were about $5,300,000; for 1897-98 $3,892,872; for 1896-97 $4,500,000.

The Siemens & Halske Electric Company of America has sold a 500-kilowatt direct-current generator to a railway at Rochester, N. Y.; also two dynamos and a lot of motors to the Glens Falls Portland Cement Company, Glens Falls, N. Y. Knowlson & Kelley Corliss type engines will be used to run the latter plant.

The Peru Steel Casting Company, Peru, Ind., has purchased from the Crocker-Wheeler Company two generators, belted, of 110 kilowatts each, and 100 horse-power motors; also one 30-ton crane and two 10-ton cranes, and a Buckeye engine. It is a new equipment.

The Berlin Iron Bridge Company, East Berlin, Conn., notes an exceedingly brisk business. We have received a list of important contracts on hand, among which those directly relating to machine tools are as follows: A machine shop for the Wheeler & Wilson Manufacturing Company, Bridgeport, Conn.; a new machine shop for the Norwalk Iron Works, South Norwalk, Conn.

It is reported from Chicago that employing machinists are considering the minimum rate of 28 cents per hour for machinists.

CINCINNATI REPORT.

In reviewing the manufacturing industries here for 1899, growth is perceptible in all lines. While 1892 was looked upon as a year of phenomenal activity in manufactures here, as elsewhere, the feeling is that 1899 far exceeds it in every particular. In machine tools, engines, and other machinery, reports show an increase of from 25 to 75 per cent., and more, over 1898. While January is generally a dull month, manufacturers have found the number of new orders received gratifying, and some think that this is the best January they have known in many years.

While prices of pig iron have remained firm in a general way, some sales of round lots have been made at a possible shading in price of 25 cents per ton.

In 1840 James Bradford & Co. started in the manufacture of flour mill machinery. The business continued under this name until 1875, when it was changed to The Bradford Mill Company. For the past ten years they have been engaged in the manufacture of machine tools, and to obtain a more appropriate designation they have lately been reincorporated as The Bradford Machine Tool Company, capitalized at $100,000. In adding to their facilities for manufacturing machine tools they will utilize two buildings—one 30x170 feet, the other 40x66 feet. They have put in a new 120 horse-power engine, and will add an entire new line of machine tools for their use as fast as orders for them can be filled. Confining themselves to a specialty, they look forward to a still larger growth of their business for this year. The Straub Machinery Company, having purchased The Bradford Mill Company's flour mill machinery business, will erect new buildings in the rear of their present plant, giving them 25,000 square feet additional floor surface, and will put in a large quantity of new machinery.

The R. K. LeBlond Machine Tool Company has added to its plant a building 150 x165 feet, one side and the front three stories high, the rest one story high. They have put in this addition a 50 horse-power motor and 300 feet of line shafting with Hyatt roller bearings. They will install several G. A. Gray Company planers. The lathes and milling machines will be of their own manufacture, to which will be added such other machine tools as may be needed. This will furnish room for 100 more men, making the total number of employees 250.

Among the new buildings going up here is that of The Blymyer Iron Works Company on the west side of Spring Grove avenue, near Township street. It is of brick, 118x320 feet, three stories and basement in front and a large story with basement in the rear. The machine shop, foundry, pattern shop, etc., will be fitted up with the most approved appliances. The company's business is largely increasing yearly, and is in great part with foreign countries.

The Dietz Machine Tool Company is occupying the first floor in its new building, where it hopes to have a force of men set at work as fast as the new machine tools ordered are received and placed in position. The Oesterlein Machine Company has moved into the second story of the Dietz Machine Tool Company's building, where it will remain for a few months until its own building is erected. It is getting everything into shape as fast as possible, has some thirty men now employed, and will give work to a larger number as fast as the new machine tools can be installed for that purpose.

In finished materials the Mitchell & Tranter Company finds the tonnage sold for last year more than double that for 1898, and the largest in the more than twenty-five years in which it has been in business. Julius Uhlein & Co. find the tonnage of their sales in finished material sold last year the heaviest on record. They are filling a large order for supplies for an exhibition of machinery in the Paris Exposition.

CHICAGO MACHINERY MARKET.

The Western representative of one boiler manufacturer says he knows of inquiries aggregating 50,000 horse-power in this market at present. Other engine and boiler men agree that the number of inquiries have increased so rapidly during the past few days as to be notable. The trade is therefore theoretically in an excellent condition from the seller's standpoint. January was not a month to be especially proud of. Aggregate engine and boiler sales fell below December, which was phenomenally large. But February is making a better record and promises to score quite a satisfactory business. Boiler makers of the better grades are promising deliveries in from three to five or six months. Engine builders say that for ordinary-sized power, running from 300 to 500 horse-power, deliveries are being promised in about eight months. There is,of course, a wide variance among makers, but that is a good average among the better class. The representative of one of the best-known boiler makers says he has given notice to his old customers that he is sold up for about five or six months and that if any purchases are contemplated this year now is the time to order.

It is said here that while boiler producing capacity has considerably increased during the past year, engine builders have made comparatively little gain in their output, owing to the difficulty of buying the required machinery. Negotiations are now pending and will be closed within a few days, it is expected, for a 5,000 horse-power engine for electric railway and lighting purposes. The delivery talked of is two years. The larger builders of engines continue to turn down the great majority of the inquiries that arrive, without even naming a time at which they can make shipment. Values are without change. Tank plate has met with a decided shrinkage in price, but boiler plate has fallen to a much less degree.

The Anglo-American Provision Company, of Chicago, will install a central plant at the stock yards and has purchased boilers of 1,200 horse-power of the Cahall type. It will in a few days let the contract for engines. The Woodstock Portland Cement Company, of Woodstock, Mich., has bought boilers of 1,250 horse-power of the water tube type and two Wheelock engines of 650 horse-power each. Cleveland, Ohio, is said to be the center of much activity at present in the power market, a number of large improvements there being under consideration or in progress. As compared with this time last year, actual business in power is said to be rather slow, b t the inquiries in sight are correspondingly larger. There are fair proportions of inquiries both for new plants and for the improvement of old ones. A large percentage is also for engines of moderate power, wanted for manufactories of various kinds. The outlook shows no check in the gait at which things in this line moved last year.

Quotations.

NEW YORK, TUESDAY MORNING,
February 13, 1900.

Iron—American Pig, tidewater delivery:—

Pennsylvania Irons:	
No. 1 X foundry	$24 20 @ $25 00
No. 2 X foundry	23 20 @ 23 70
No. 2 plain	22 20 @ 22 70
Alabama Irons:	
No. 1 foundry	22 25 @ 23 00
No. 2 foundry	21 25 @ 22 00
No. 3 foundry	20 25 @ 21 25
No. 1 soft	22 25 @ 23 00
No. 2 soft	21 25 @ 22 00
Foundry forge	19 75 @ 20 75

Bar Iron — Base sizes — Refined, mill price on dock, 2.25 @ 2.35c.; store price, 2.50 @ 2.60c.; common from store, 2.45 @ 2.50c.

Tool Steel—Base sizes—Standard quality, 7 @ 8c.; extra grades, 12 @ 14c.; special grades, 16c. and upward.

Machinery Steel—Base sizes—Ordinary brands from store, 2.85 @ 3c.

Cold Rolled Steel Shafting—Base sizes—From store, 4 @ 4¼c.

Copper—Lake Superior ingot, 16¼c.; electrolytic, 16 @ 16⅛c.; casting copper, 16c.

Pig Lead—Wholesale lots, 4.70c., New York delivery; carloads, 4.72½ @ 4.75c.

Pig Tin—In 5 and 10-ton lots, f. o. b., New York, 29⅞ @ 30c.

Spelter—Prime Western, 4.75 @ 4.80c., New York delivery.

Antimony — Cookson's, 10⅞ @ 11c.; Hallett's, 9¾c.

Lard Oil—Prime City, present make, 51 @ 54c. in jobbing lots.

Some Things Seen at the Works of the Fellows Gear Shaper Company — New Features of the Gear Shaper.

The Fellows Gear Shaper Company has recently completed an addition to its shop. The new portion is 90 feet long, giving a total floor space of 150 by 45 feet. A recent visit to the shop brought to notice many interesting things, of which a few are here detailed.

The leading changes which have been incorporated in the machine since its original publication in our issue of December 9, 1897, relate to the saddle or cutter ram head. The principal object sought was a better support of the cutter through reduction of the overhang from the ram, the ultimate aim being to adapt the machine to the use of larger cutters. The cutter ram *a* of Figs. 1 and 2 is now made partly circular in form, the left-hand cylindrical surface of Fig. 2 being the principal sliding surface, while gibs *b* and *c* prevent rotation of the ram. The diameter of the cylindrical surface is slightly greater than that of the cutter. The cutter is supported close up to the ram, and in its reciprocation it follows the ram into the guide.

It will be remembered that the cutter spindle has two movements—a reciprocating, planing movement and a slow, turning movement in unison with the blank being cut. The reciprocating movement is obtained from the ram *a* and the rocking pinion *d*. The cutter spindle is free to turn in the ram and is made to turn by the mechanism shown at the top of Fig. 1, and in horizontal section in Fig. 3, the form shown being also new. The worm *e*, Figs. 1 and 3, turns the worm wheel *f*, which in turn revolves the slide *g*. Slide *g* is in halves and has a cylindrical guide surface *h* and flat surfaces *i j* which permit the sliding member *k* to reciprocate vertically, but cause it to turn with *g*. Piece *k* is keyed to the cutter spindle *l*, which in its reciprocation causes *k* to follow it, while *k* in turning causes *l* to follow it.

A photographic view of these parts, disassembled, is shown in Fig. 4. It is clear that by making the guiding surfaces *i j* of Fig. 3 helical, as in Fig. 5, the reciprocating motion will likewise be helical, and the machine may be thus adapted to the cutting of helical or "spiral" gears.

The shape of the saddle has also been materially modified by cutting it away on the right and extending it on the left, as shown in Fig. 6. The chief object of this is to adapt the machine to the cutting of gears which are formed integral with long quills. Fig. 6 shows such a piece in the machine, the piece being, in fact, the quill of a lathe back gear, the seat of the large gear being at *m*.

Fig. 7 is from a recent photograph, and shows the machine in its present form and set up for cutting internal gears, for which work it is peculiarly adapted. The work shown in the machine in this view is the back gear of the machine itself, and has, in fact, two gears—one internal and the other external—in one casting. The uncut blank for the external gear is plainly seen in the picture. Fig. 8 shows a section of this piece of work and its immediate surroundings. The full lines at the right show the cutter in position for cutting the internal and the dotted lines at the left for the external gear. As this class of work must be done on the pushing stroke, the work support ordinarily used with the pulling stroke is not available, and a new rolling work support has been provided, as shown in Fig. 8. This support is fixed in diametrical position, but as this class of work is usually done with a supporting face-plate below the gear, the support acts through a wide range of sizes.

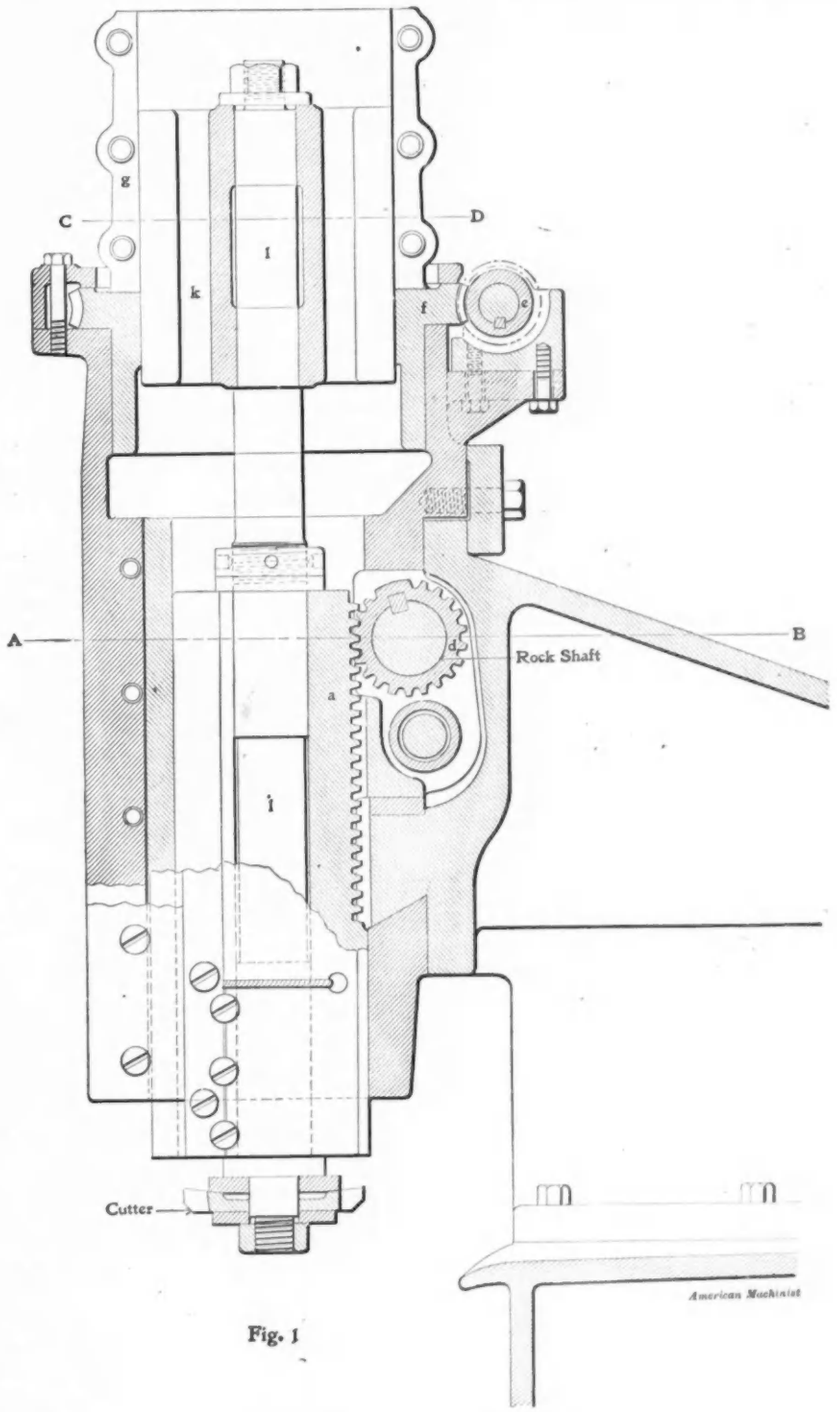


Fig. 1

VERTICAL SECTION OF RAM HEAD.

A CURIO IN GEAR CUTTING.

A great many oddities and curios can be made on this machine, and Fig. 9 shows a recent one that, we believe, was made for the purpose of making the action of the machine clear to a Patent Office man, here or abroad. One of the machines has been adapted to the stocking out of the

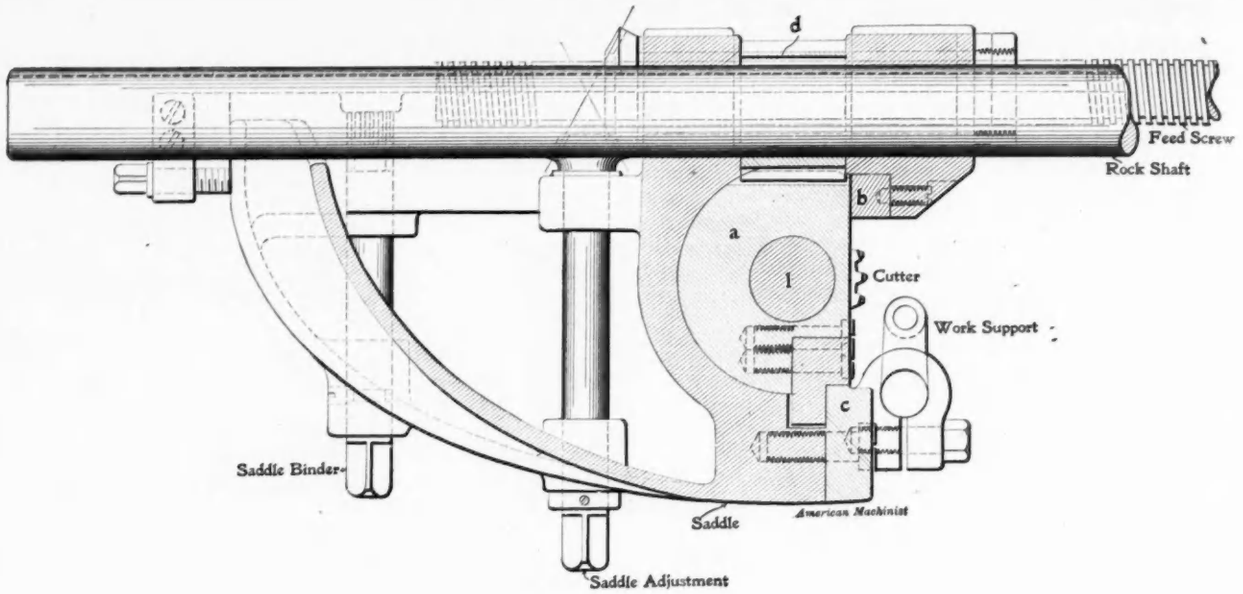


Fig. 2

HORIZONTAL SECTION OF RAM HEAD AT A B, FIG. I.

cutters used with it, by inclining the work spindle so as to give the necessary clearance to the teeth. Such clearance makes the cutter smaller at one edge than at the other, and Fig. 9 shows the work produced by this machine when the blank is increased in length. The piece produced is, in a sense, a bevel gear, but with very peculiar teeth. At the large end the teeth are extended almost to a point, while at the small end they are undercut, but the actual depth of the teeth is the same from end to end. It will be remembered that in the involute tooth profile there are really two curves—the wrapped curve which forms the acting surface and the traced curve which forms the clearance. At the large end of the piece shown the wrapped curve is exaggerated at the expense of the traced curve, and at the small end the reverse is true. In fact, at the extreme large end the curve is all wrapped, there being no clearance, and at the extreme small end the curve is all clearance, there being no acting surface. On some of the teeth where the light was favorable, a line may be seen extending from the point at the small end of the root at the large end,

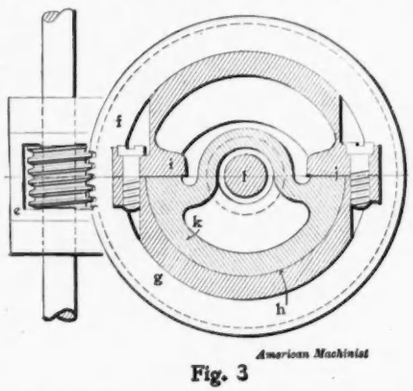


Fig. 3

HORIZONTAL SECTION OF RAM HEAD AT C D, FIG. I.

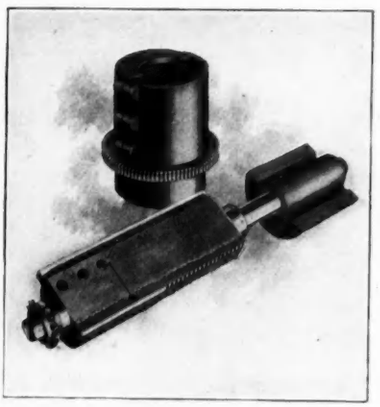


FIG. 4. RAM, CUTTER SPINDLE AND GUIDE.

which marks the transition from wrapped to traced curve. This piece of work may be described as a gear having a conical pitch surface as in a bevel gear, but a base circle of fixed size as in a spur gear. The line on the teeth marks the base circle at any point.

AN INTERESTING SPECIAL BORING FIXTURE.

Figs. 10, 11, 12 and 13 show a boring fixture used in boring the bearings for the driving cone pulley and back gear shafts of the machine. The work is essentially the same as boring the corresponding bearings of a lathe headstock, except that it occupies one corner of a casting of considerable size and weighing about 800 pounds, and which it is impracticable to place on a boring machine. Fig. 10 shows the appearance of the fixture in front and rear views and in place upon the casting to be bored. It is accurately positioned for distance and parallelism by being brought to contact with the already planed edge of the surface on which the ram head slides. Two cutters will be seen projecting through the holes just made by them. The same cutter spindles carry two additional cutters at their rear ends for simultaneously boring the holes for the opposite ends of the shafts. The cutters have the teeth carried out to full square corners to avoid the tendency to follow an untrue core. The four cutters are all seen in the plan view, Fig. 11. The outlines of the piece being operated upon are shown in dotted lines, the edge from which the fixture is positioned being at *a*. Jack screws *b*, *c*, *d*, *e* steady the fixture and take the thrust of the cut. Fig. 12 is a vertical cross-section and shows the general arrangement of the gearing. Fig. 13 is a longitudinal section through one of the cutter spindles, and shows the arrangement of the feed gearing, which is very ingenious. Gear *f* drives the spindle by a sliding feather, and gear *g* feeds it by the screw thread *h*. Pinion *i* has 17 teeth and pinion *j* 16, the feed being thus differential and of a coarseness due to the difference of the speed of the screw threads cut in gear *g* and the spindle within. The cut completed, the clutch handle *k* is drawn to the

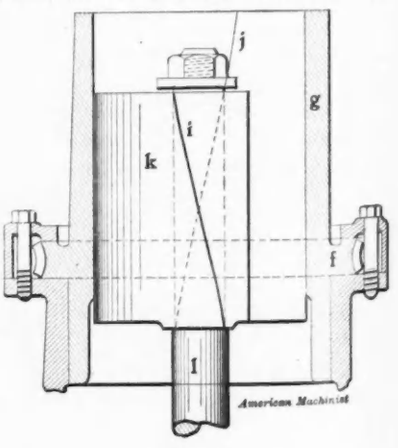


Fig. 5

FORM OF SPINDLE GUIDE FOR CUTTING SPIRAL GEARS.

right, thus opening the clutch jaws between gear *l* and pinion *i* and stopping the motion of the latter and the rotation of the cutter spindle. Pinion *j*, however, continues to revolve and with it gear *g*. The lengthwise motion of the spindle is now that due to the full speed of the nut, or sixteen times the feeding rate, and by tracing the motion through, it will be seen to be reversed in direction, the spindle being thus quickly drawn back. The method of attaching the cutters to the spindles to permit quick changes in substituting the finishing cutters will be seen in the small detail view.

AN IMPROVED POWER HACK-SAW.

Fig. 14 shows an attachment to a power hack-saw for revolving the stock as the work proceeds. The effect is to always present to the saw a round surface instead of a straight one, as usual, and thus to increase the effectiveness of the machine and the size of stock which it can work up. Three of these machines are in regular use and they work up 4¾-inch tool-steel bars with ease. The axis of the work is set slightly out of square with the saw, in order to cut a kerf slightly wider than the saw, and thus prevent binding and the tendency to crowd off sidewise. The machines are used for cutting off blanks from which the cutters are made for the gear-shaping machine, and instead of using only one saw bade, Mr. Fellows has placed two blades in the frame, side by side, and at a distance from each other just equal to one of the blanks; thus two blanks are cut off for each setting of the

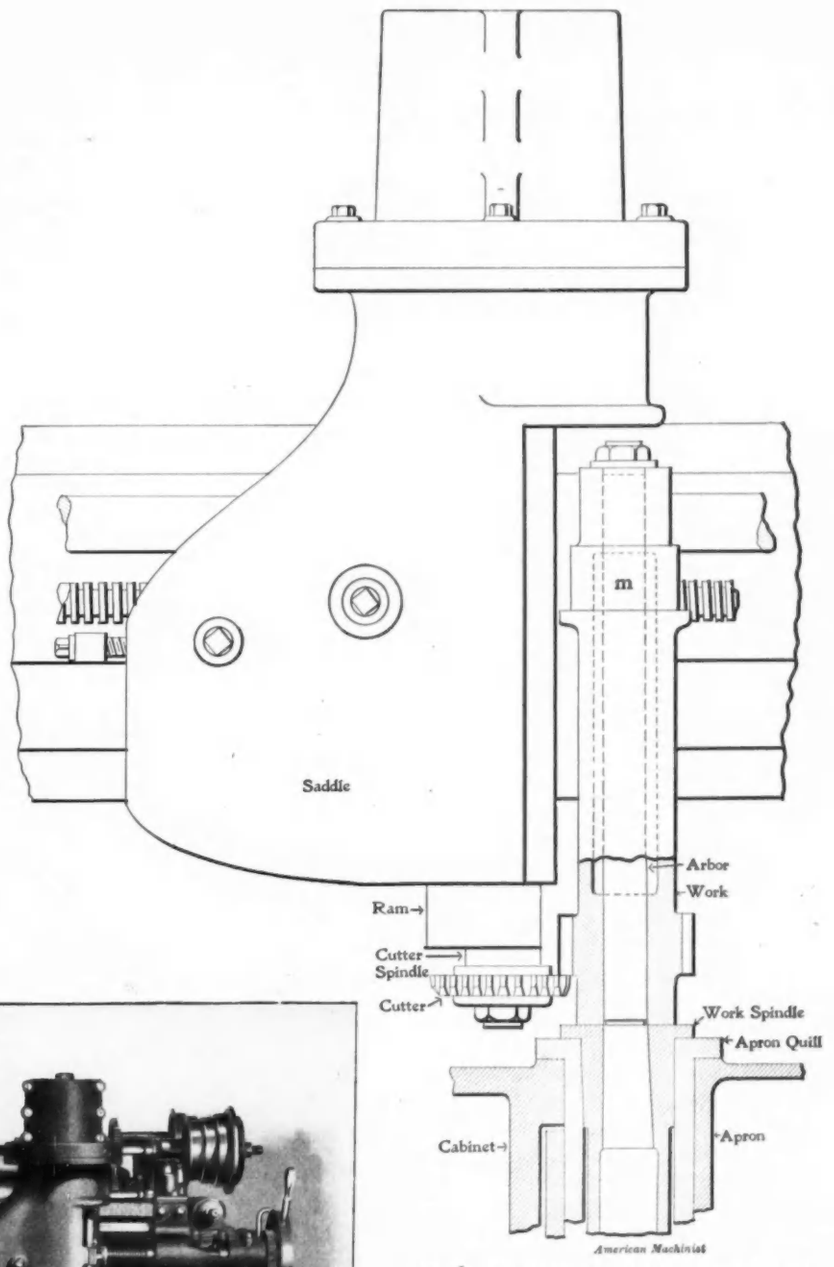


FIG. 6. CUTTING THE PINION OF A LATHE BACK GEAR.

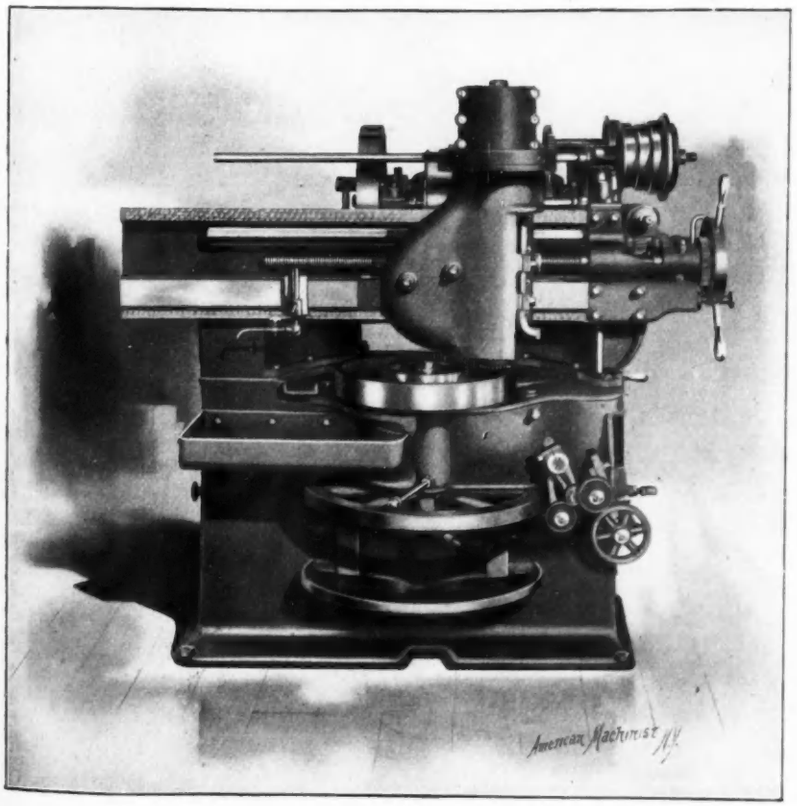


FIG. 7. GEAR SHAPER SET UP FOR CUTTING INTERNAL GEARS.

stock, and considerable time is saved. This, however, would probably not be practicable were it not for the fact that the stock is rotated, and besides the other advantages of this rotation, it is found that the stock is cut off much more accurately than is the case where it is not rotated. Of course the machine as it stands is not put forth as an example of machine design, but is a patchwork job intended only for the stated purpose, the plain machines being, of course, the commercial article.

This gear shaper, like most radically new things, has developed and brought out many interesting corelative things, some of which were previously unknown, or at least very imperfectly understood. Next week we shall more fully treat one of these that is only touched upon in the present article.

Crank Shafts for Large Engines.

BY W. H. BOOTH.

Since writing on the question of the sizes of crank shafts, which I was induced to do by the discussion that has arisen in regard to the Glasgow engines, I have noticed several criticisms of my letter which point out that I am entirely wrong and that the real question is one of bearing pressures. Now, I had not overlooked this aspect of the question, though I believe on the subject of the intensity of bearing pressure there is a considerable difference of opinion. In the first place, the customary method of defining the pressure on a bearing is to take the horizontally projected area. This area is simply the length of the bearing multiplied by the diameter. Everyone seems to be agreed upon this method, though doubtless all are equally agreed that, so calculated, the intensity of the pressure is very much less than the actual intensity, for it is improbable that the true bearing area extends over an arc of more than 90 degrees. But this is of no account to argue upon, as it affects all alike.

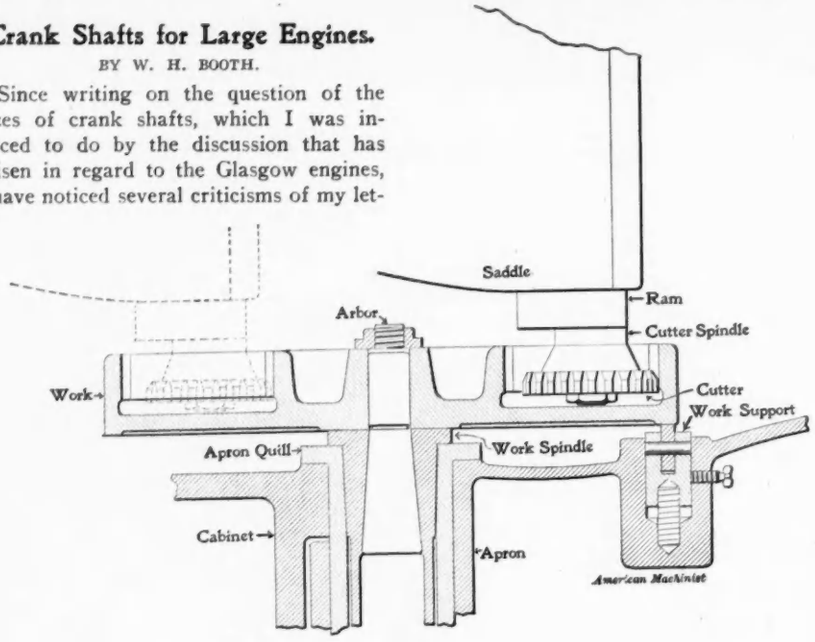


Fig. 8

CUTTING INTERNAL AND EXTERNAL GEARS ON THE SAME CASTING.

Calculated then on the projected area, I once made a number of calculations of actual examples of engines of considerable power, with flywheels ranging upwards of 180,000 pounds, and found that a pressure of 130 pounds per inch of projected area was perfectly satisfactory, even with ordinary lubrication. The argument has been advanced that excessively large bearings, giving pressures much less than this, are necessary in order that wearing down may be kept very low and the armature may not be put out of magnetic balance, increasing the downward pressure in consequence. It would seem rational to place the armature, as far as practicable, out of balance in the original design, so that such effect as it may have shall be upward, and considerable wear may take place before the non-balance begins to exert a downward force. But is not this argument about the rapid wearing down of bearings just a little stretched? Some years ago I had occasion to repair an old engine which had a 30-foot flywheel and a 26-foot gear wheel on a shaft carried on

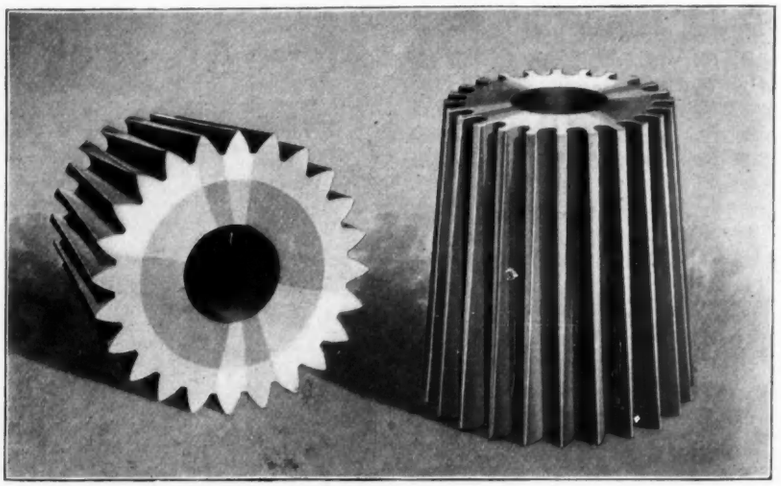


FIG. 9. A CURIO IN GEARS.

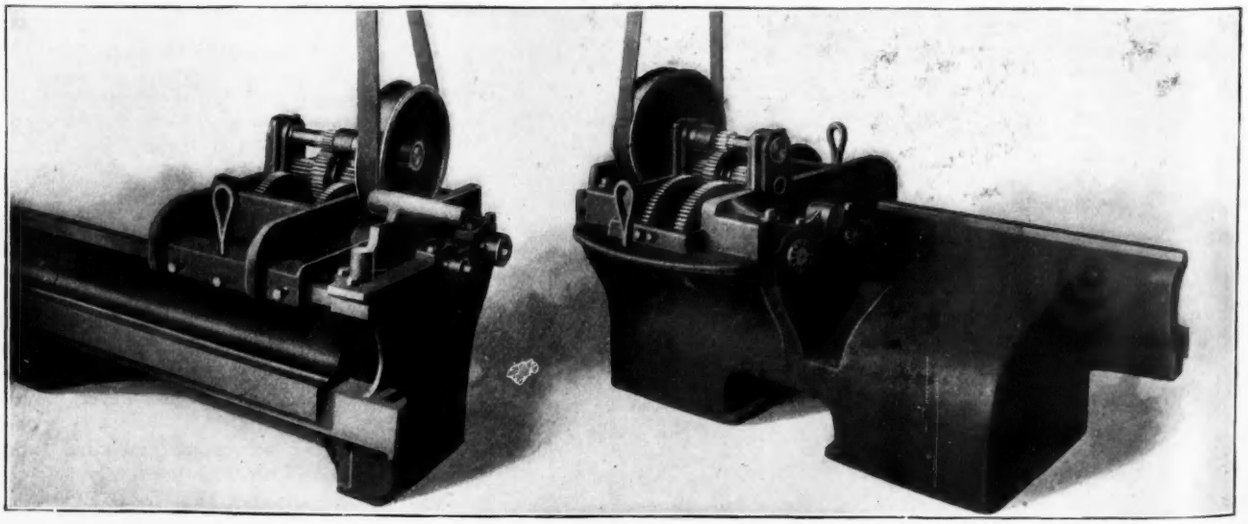


FIG. 10. A BORING FIXTURE.

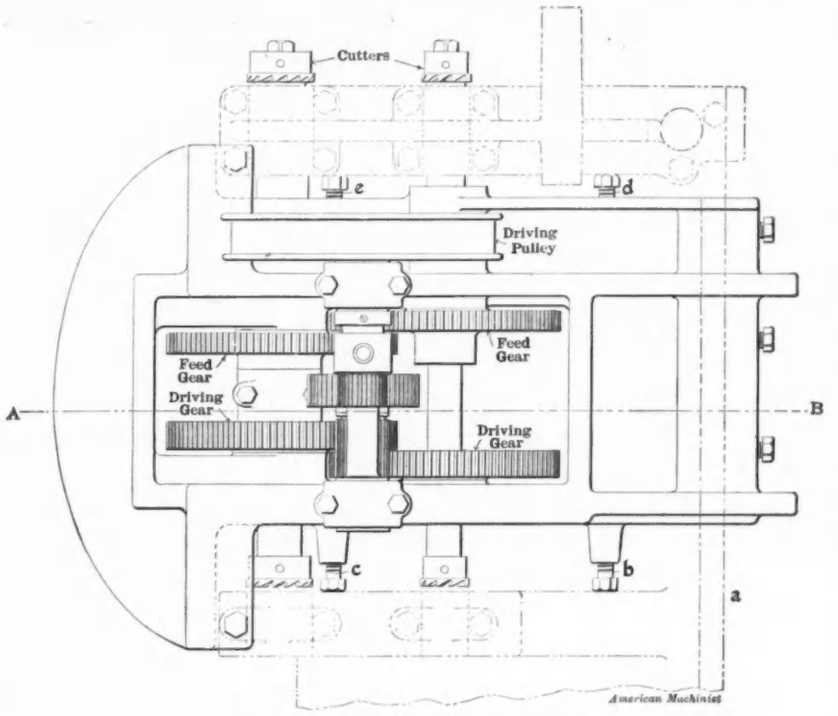


FIG. 11. PLAN OF BORING FIXTURE.

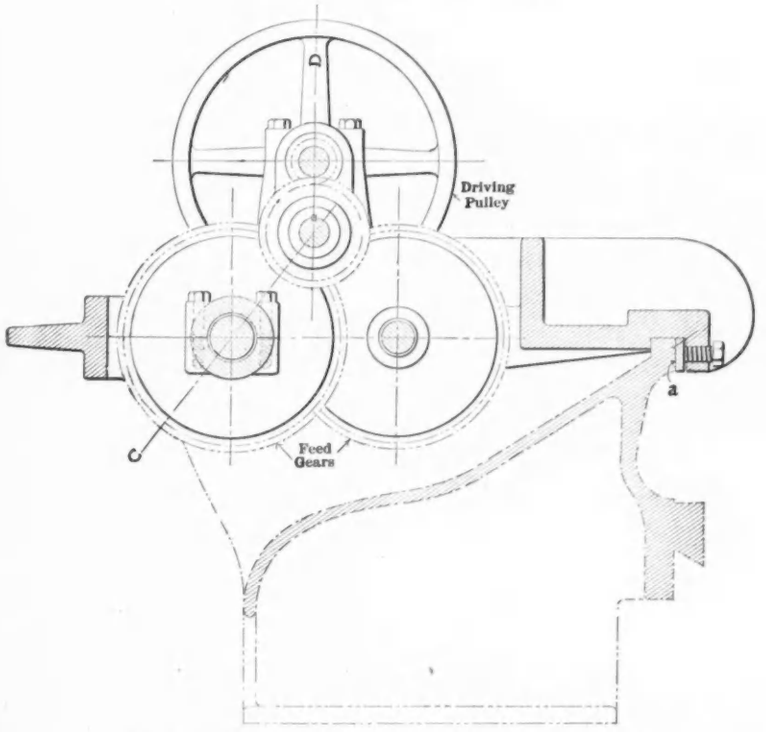


FIG. 12. SECTION OF BORING FIXTURE AT A B, FIG. 11.

a bearing between the two. This bearing was one of the old-fashioned kind, very little, if any, longer than its diameter. I have no record of the pressure intensity, but, from recollection of the dimensions, should say it may have been as much as 200 pounds per square inch of projected area. Now this bearing, hidden away in a masonry wall and difficult of access, was lubricated through a long pipe, and had not been touched to my certain knowledge for twenty years. It had a light cap as a dust protector only, for there was no upward pressure, and when we examined this cap we found that there was less than one-eighth of an inch of space between cap and shaft, and this proved that the wear in twenty years had not been so much as one-eighth of an inch. True, the speed had been low, only about 20 revolutions per minute, but I am pretty certain that with good gunmetal and proper lubrication the wearing down of a crank-shaft bearing should be very slight, and it appears a very poor commentary on modern engine design if provision cannot be made to compensate wear.

There is another view of heavily loaded crank shafts to which, personally, I am inclined to attach far greater weight than to that of pressures. I refer to the bending of a shaft under its load as a beam, and I have very little doubt in my own mind that many cases of apparently excessive diameters are due to painful experience acquired by neglect of this. I have been laughed at for even suggesting that a heavy steel shaft will bend under a heavy flywheel because the amount will be so very trifling. It is these trifling little things which always cause trouble in mechanical engineering, and I think it will be admitted that if a shaft bends at the middle only the hundredth part of an inch, the two ends will slope upwards at a certain small but calculable angle. If this is so, and it obviously must be, then the inner ends of the shaft bearings only must theoretically be resting on its horizontal brasses. I have seen shafts thus laid in carefully levelled bearings, which showed unmistakable signs that the pressure on a 36-inch neck was all concentrated at the inner 4 inches or less. The fault would have been practically cured by a thin packing of a soft lead, or felt, or pine, but this would have been inadmissible in accurate metal-to-metal high-class work. Obviously in such a case the remedy is to slope the bearings, but the result in practice has been to use swivelling bearings and to shorten the span of the shaft, which is a very important item.

The rule I worked out for heavily loaded shafts is as follows: $D = 3\sqrt[3]{\frac{WL}{2}}$, in which D is the middle diameter of the shaft where the wheel sits; W is the weight in tons (2,240 pounds) of the wheel, and L is the span of the shaft, in feet, from center to center of the bearings. Let an example be assumed of a wheel of 100 tons and a span of 10 feet. Then we have $D = 3\sqrt[3]{\frac{1,000}{2}}$, or $= 24$ inches, nearly. Let the length of span be 14 feet and D becomes nearly 26¾ inches.

If the diameter of the bearing is made, say, 21 inches, and its length be 42 inches, its area will be 882 square inches to carry a load of 50 tons, or 112,000 pounds. This represents 127 pounds unit-pressure. In the pursuit of this subject I found it necessary to go pretty fully into the question of shaft diameters, slopes and deflections. I first determined the amount of deflection of a circular beam of diameter $= d$ in inches, span $= S$ in inches and $P =$ load in pounds. The deflection is $\frac{P \times S^3}{48 E I}$, where E is the modulus of elasticity, which I took as 30,000,000 for steel, and I is moment of inertia, and is $0{\cdot}0491\ d^4$.

The rate of slope of a shaft at the necks

is R, then $R = \frac{P \times l^2}{16\,E\,I}$. Reducing this to a practical form for the load W in tons of 2,000 pounds and the span in feet, L, the rate of slope becomes $R = \frac{W L^2}{81\,d^4}$, or for tons of 2,240 pounds $R = \frac{W L^2}{70\,d^4}$.

On the same basis of the span stated in feet and the load in tons of 2,240 pounds, I determined the diameter of the necks as $d = \sqrt{4{\cdot}5\,W}$, and the length of neck in inches $= l = \sqrt{18\,W}$. Thus $l = 2d$, as to which more anon. The unit-bearing pressure to secure these formulas I took as $x = 130$ pounds, as already stated. Then $d.l.x = 1{,}170\,W$, $d\,l = 9\,W$, and the amount by which one end of the bottom brass should be raised to allow for slope $= A = \frac{l}{R}$.

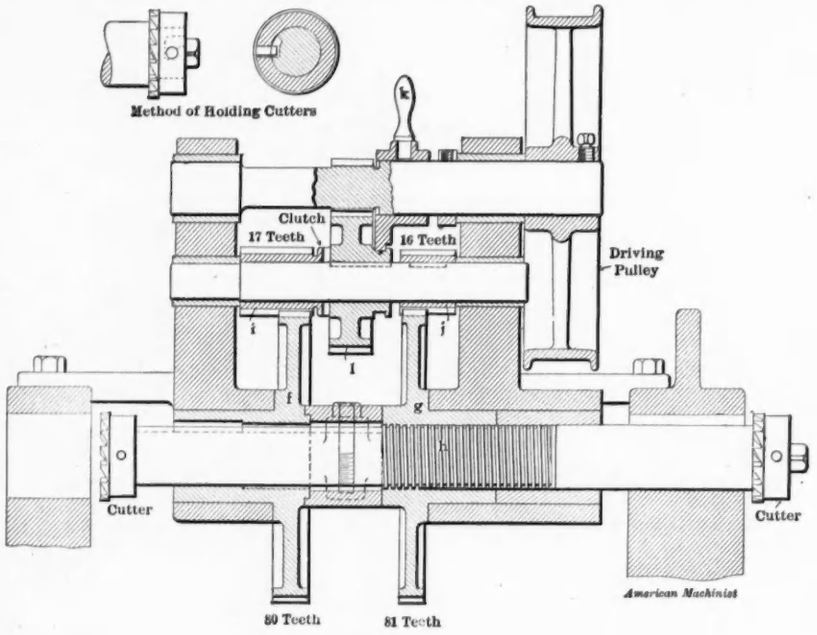


Fig. 13

SECTION OF BORING FIXTURE AT C D, FIG. 11.

It is desirable to keep the length of a bearing as small as possible, because the bending stress due to steam pressure is presumed to act at a lever arm of the length from the neck center to the line of the crank-pin center. Neglect of bearings may seriously increase the stress, and it is of great importance to keep the side brasses of a bearing in such order that they maintain efficient contact on the neck close up to the crank.

In the calculations which led up to the above formula the law of Wohler with respect to reversal of stresses was taken into account, and resulted in very low unit-stresses being taken—about 5,000 pounds for reversed bending, 8,000 pounds for a stress varying from nil to a maximum, and 6,400 pounds for torsion varying from nil to maximum. The 5,000 applies to shaft centers and the other two figures to the necks, but it was noted that the dimensions thus obtained for the necks of compound engines might give smaller figures than demanded by the unit bearing pressure of 130 pounds. It was also noted that the neck diameter $d = \sqrt{4{\cdot}5\,W}$ was correct for compound engines at the then boiler pressure of 100 pounds, but should be increased to $\frac{21\,d}{20}$ for simple engines, and l should be reduced, so that bending stresses on the necks due to steam pressure may be provided for.

Now the tendency in large modern engines appears to have been to use shafts of considerable span, and it is easy to see that some of the large diameters recently employed have been due not in any way to the necessity of bearing pressure, but to the demands of stiffness and the prevention of deflection.

Just as it is desirable to keep a crank bearing as short as possible, so also should the crank pin and crank web be short, for all these three factors determine the severity of the bending moment at the neck, and a shaft is weaker against bending than torsion. This accounts for the traditional objection to overhung necks.

But where shafts can be short between bearings it seems to me excessively uneconomical practice to put in a heavy revolving brake for fancied reasons of heavy wear. If an armature is going to be lowered it would be a small matter to arrange the fields so as to be capable of suitable adjustment. But good bearings, *properly lubricated,* will not wear so extravagantly after all, as to which point of lubrication there is more to be said.

London.

The New Shops of the Potter & Johnston Co.

We present herewith sections and interior views of these shops which, without much explanation, will give a good idea of their layout and equipment.

The section views, Fig. 1, show the building to be in the main of one story, but with two stories at the street-front end. The upper story of the two-story portion is used for the business and drawing offices and for the pattern shop. The lower story of this portion opens directly into the main shop, and is, in fact, part of it, forming the inspection and packing departments. The views show the north and south walls to be composed principally of windows, which are carried well up to the ceiling in order to throw the light well into the interior. Skylights are also freely provided, and the photographs show that the lighting is very general and satisfactory.

The leading products of the shop are the manufacturer's lathe, shown in our issue of January 12, 1899, an automatic turret lathe, and two sizes of shaping machines. All of these machines will be seen in process of erection in Fig. 2, which represents the erecting portion of the main floor. The portion of the shop shown in this view is the left-hand bay of the lower cross-section of Fig. 1. The next bay is occupied by the lathe department, which may be seen in the background of Fig. 2. The third or boring and planing department, shown in Fig. 3, occupies the central bay, and has a substantial hand-operated crane above it. At the right of this is the general tool department, occupying two bays and shown in Fig. 4.

The building will be seen to be of the slow-burning construction, which is so popular in New England. The wall at the east end, which appears at the right of the upper section of Fig. 1, is a curtain wall only, and is not an essential part of the structure of the building. It may therefore be removed at any time when an extension of the plant is desirable.

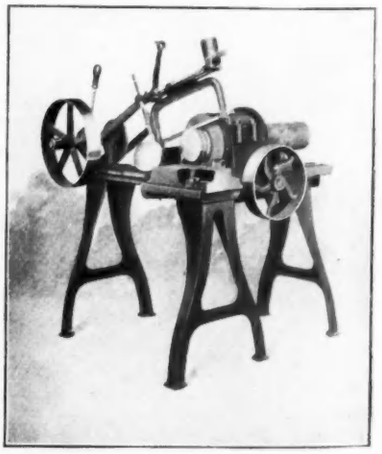


FIG. 14. IMPROVED POWER HACK SAW.

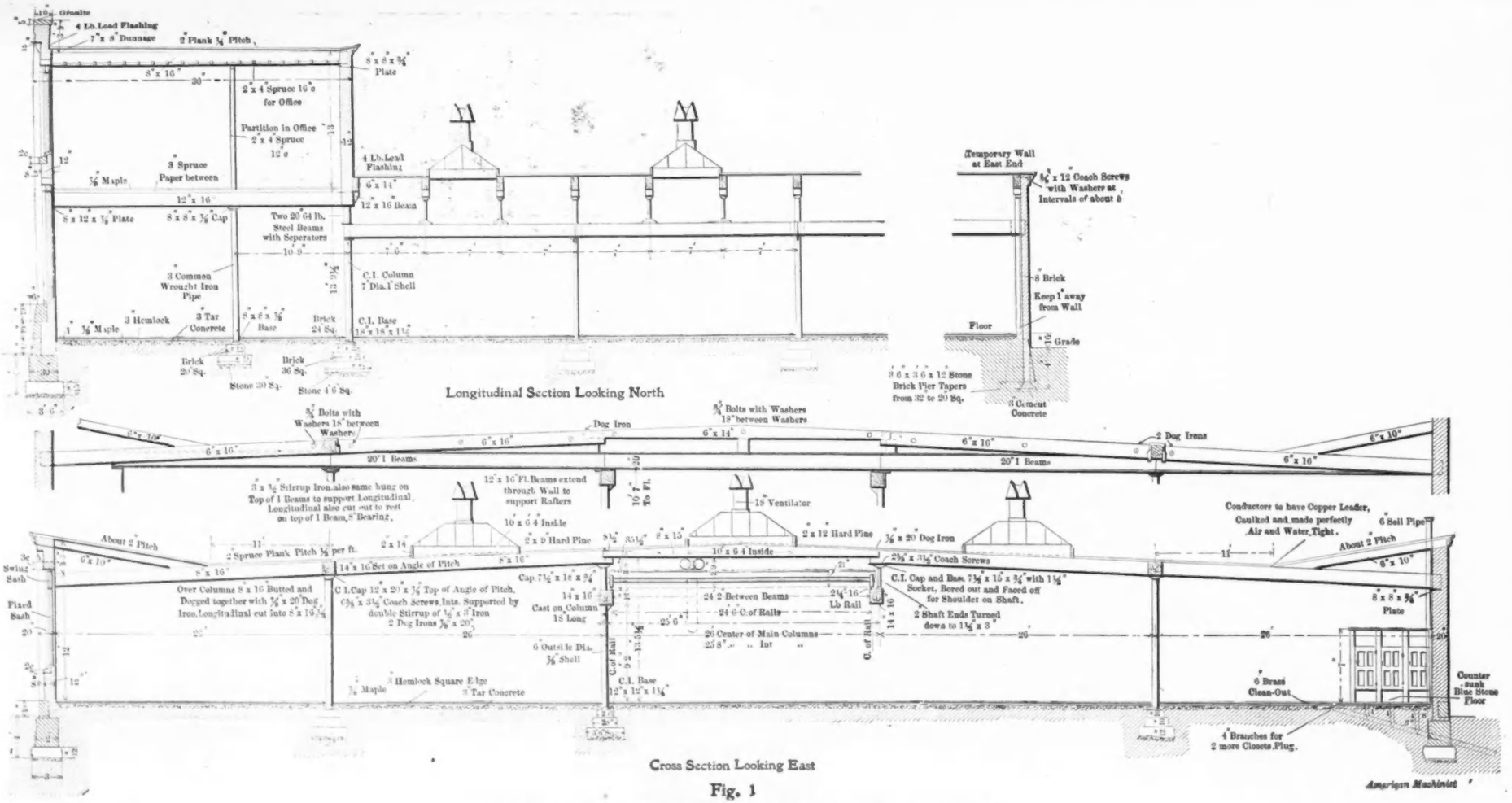


Fig. 1

SECTIONS OF THE NEW WORKS OF THE POTTER & JOHNSTON COMPANY.

Cylinders Under Internal Pressure.

BY ALFRED PETTERSON.

For the strength of cylinders under pressure a variety of formulas is given in the different pocket books and text books, all of them giving different results. The writer remembers having once seen an inquiry in one of the technical journals as to the best formula to use for cylinders under internal pressure, but has not as yet seen a satisfactory answer. Contrary to what would be expected, Mr. Kent in his pocket book, on pages 287 and 288, refers to two formulas only, which, as his example shows, give widely varying thicknesses for the same pressure and diameter. It is a disappointment to many of the users of his valuable book, that he makes no attempt to show which formula is right or which one may be used with safety. He thus leaves the subject in as dark a state as any of the older pocket books. To settle the question for himself, the writer years ago went through the subject carefully, and although the investigation covers some mathematical work, I will try to show the results in as plain language as possible.

Before we proceed to examine the different formulas, we will first see what takes place in a thick cylinder when under internal pressure. It will first be shown that if the cylinder is thick in proportion to its internal diameter, the stress upon its inside and its outside circumference

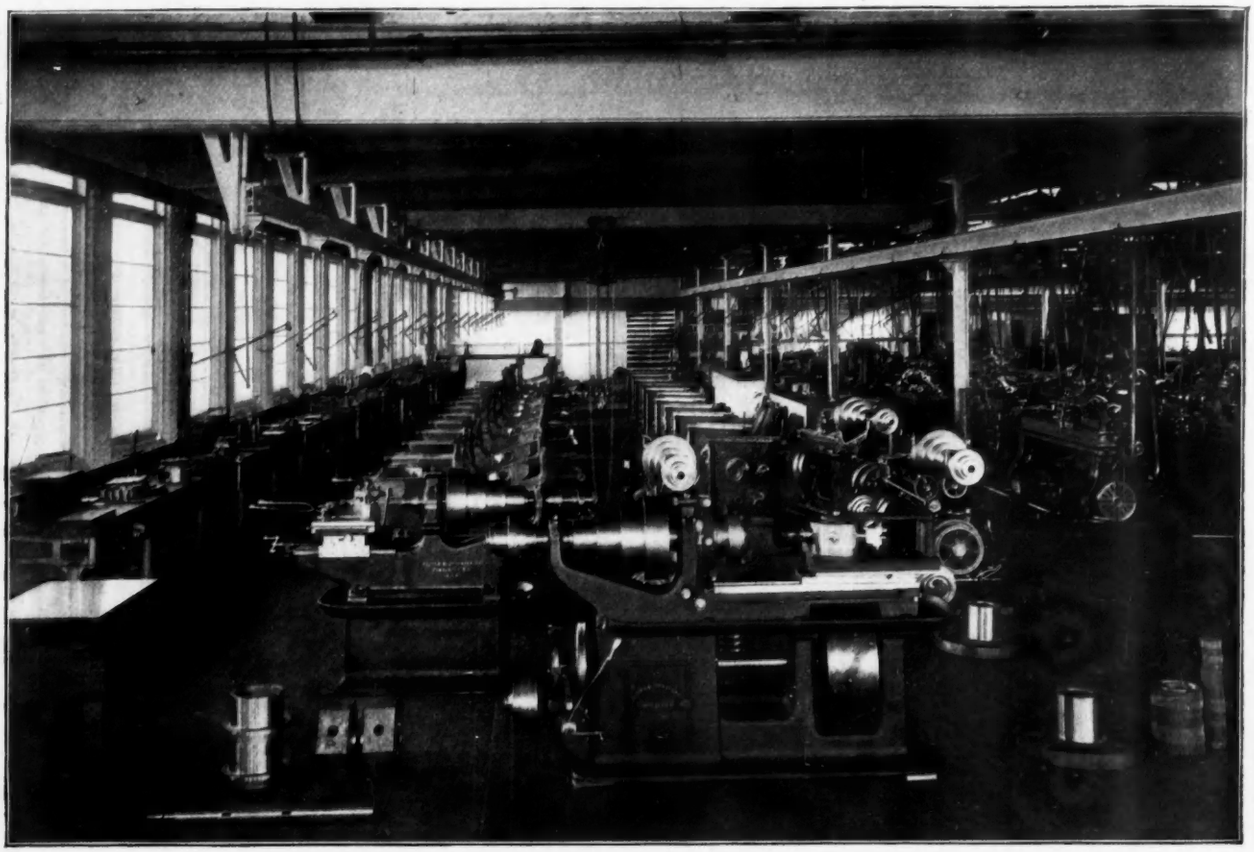


FIG. 2. ERECTING DEPARTMENT.

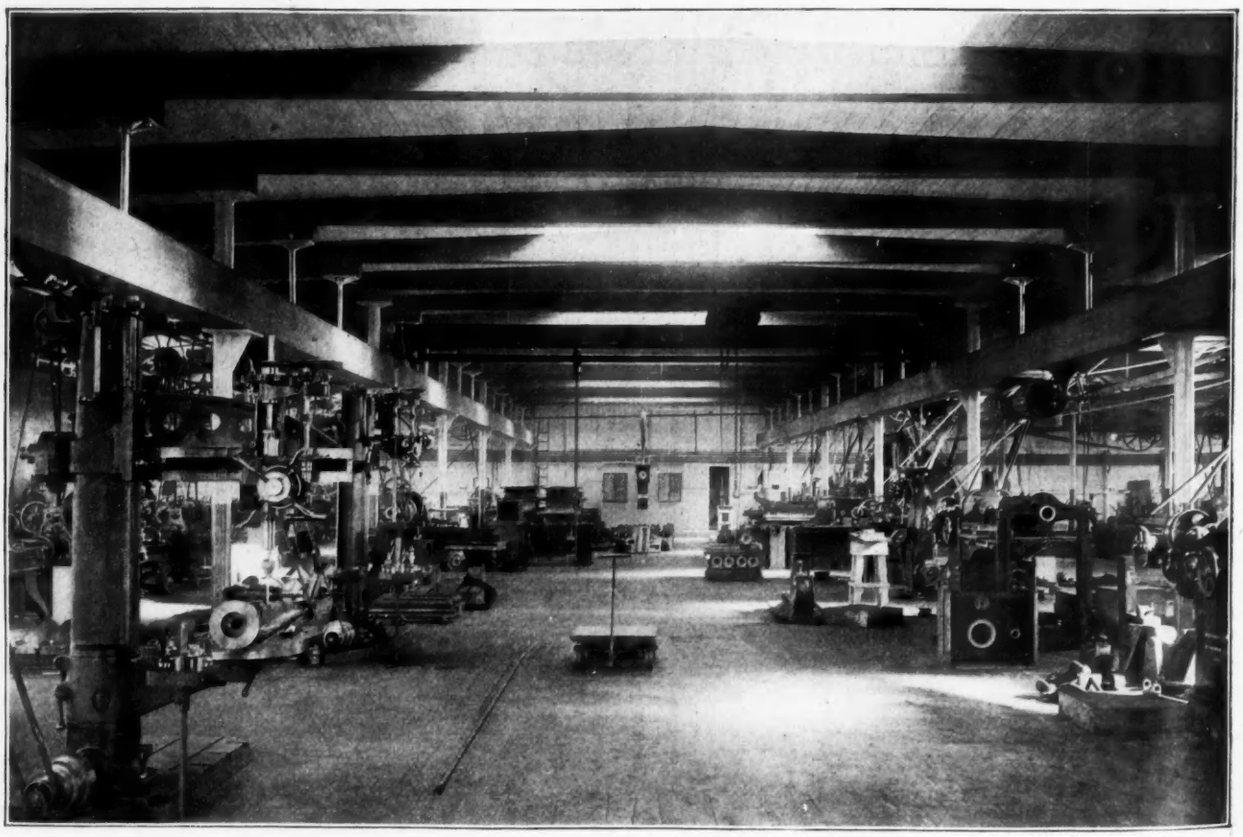


FIG. 3. BORING AND PLANING DEPARTMENT.

will not be anyway near alike. Just as soon as the pressure comes on, the cylinder wall will stretch or expand. If we now suppose the thickness divided into concentric rings, it is easy to see that the outside ring will be longer than the inside one. Thus, if the thickness is equal to one-half the diameter, the outside ring will have, say, twice the length of the inside one, and each pound strain per square inch will stretch the outside ring twice as much as the inside one. The outside ring will therefore offer the least resistance to the internal pressure, and the farther in we get the more resistance is offered, giving the most resistance by the inside ring.

stress caused by the pressure on the ends of the cylinder will cause an elongation in this direction with a further decrease of section. Thus, as the internal pressure comes on the thickness will diminish, which again will increase the strain per square inch of the section left.

It is also easily understood that this circumferential stretching and radial compression of the cylinder wall will increase the bore with a further increase of the strain on the material of which the cylinder is made.

A correct formula for the thickness of cylinders under internal pressure must thus imply the following three facts:

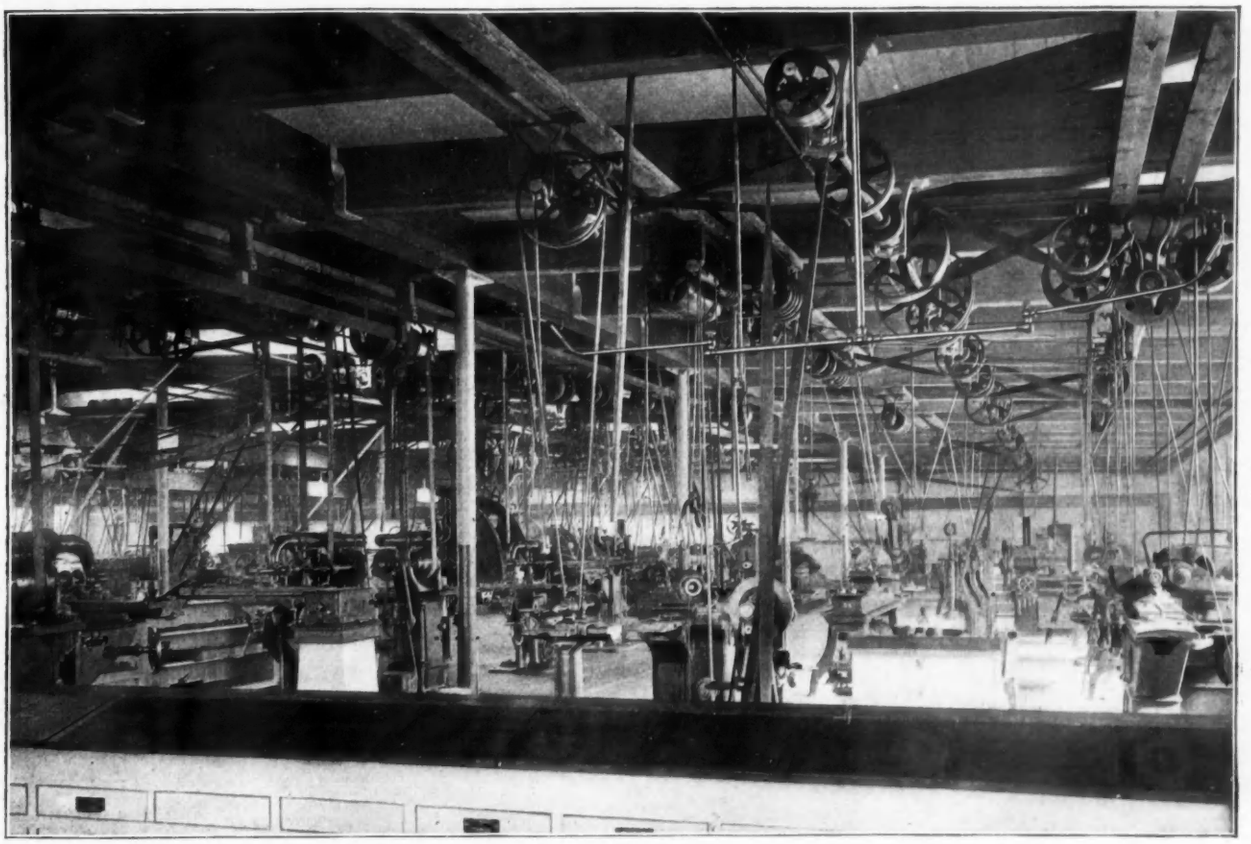


FIG. 4. GENERAL TOOL DEPARTMENT, POTTER & JOHNSTON SHOPS.

It follows, therefore, that the inside ring will be strained the most and that failure will commence inside.

For this reason we find the "built up" guns with the outside rings shrunk on to the inside ones so as to bring these under an initial compression, which must be equalized before tension can take place.

But this unequal tension and elongation of the different layers of a cylinder wall under internal pressure is not all that takes place. It will be easily understood that no elongation can take place without a corresponding diminution of the section. This will again be augmented by the compression which takes place by the outside layers pressing upon the inside ones on the one side and the pressure of the fluid or gas on the inside. The longitudinal

(1) The stress per square inch of the section varies with the distance from the center.

(2) The elongation that takes place decreases the original thickness.

(3) The expansion increases the bore.

The simplest formula commonly used for thin cylinders does not take any of these three facts into consideration, and can therefore only be used for low pressures and where the thickness will be small compared with the diameter.

We will here use the following notation:

p = internal pressure per square inch.

s = stress allowed per square inch of section of the material.

t = thickness of cylinder in inches.

r = inside radius of cylinder in inches.

$e = 2.718$, which is the base of hyperbolic logarithms.

We have then per inch length of the cylinder:

$$p\,r = s\,t \text{ or } p = \frac{s\,t}{r} \text{ or } \frac{t}{r} = \frac{p}{s} \qquad (1)$$

which, as said, can only be used for low pressures.

In the "Konstrukteur," by Prof. F. Reuleaux, the following three formulas for thick cylinders under internal pressure are given:

Brix's formula:

$$p = s\left(hyp.\,log.\,\frac{t}{r} + 1\right) \text{and } \frac{t}{r} = e^{\frac{p}{s}} - 1 \qquad (2)$$

Lamé's formula:

$$p = s\,\frac{(r+t)^2 - r^2}{(r+t)^2 + r^2} \text{ and } \frac{t}{r}\left(\frac{s+p}{s-p}\right)^{\frac{1}{2}} - 1 \qquad (3)$$

Barlow's formula:

$$p = \frac{s}{1 + \frac{r}{t}} \text{ and } \frac{t}{r} = \frac{p}{s-p} \qquad (4)$$

Prof. Reuleaux also states that Brix's formula is figured under the supposition that the thickness does not change when the pressure is applied. Barlow supposes a change, but so that the area of the transverse section of the wall remains the same. Lamé makes no such supposition, but figures carefully the strains that take place at every distance from the center, caused by the interior pressure, and his formula should thus give the most exact results.

This statement we shall consider further later on.

Lamé's as well as Barlow's formula shows that when $p = s$ we get $\frac{t}{r} =$ infinity, and the working stress s gives thus the limit for the internal pressure, while the practical limit will be less than s. It is evident that as soon as the internal stress reaches the elastic limit of the material, the inside layers will take a permanent stretch, and for still more increase of pressure it will rupture from the inside.

We may also note that if we make $p = s$ in Brix's formula, we get:

$$\frac{t}{r} = 2.718 - 1 = 1.718, \text{ or } t = 1.718\,r,$$

while formula (1) would make $t = r$ for $p = s$.

Formula (2) is the same as the one quoted in D. K. Clark's pocket book under the form:

$$p = s \text{ hyp. log. } \frac{\text{outside diameter}}{\text{inside diameter}}$$

Formula (3) is quoted by Kent as Burr's and formula (4) as Merriman's formula.

To illustrate the difference in these four formulas, we will use Mr. Kent's example with

$s = 8{,}000$ pounds per square inch,

$p = 4{,}000$ pounds per square inch,

and $r = 4$ or 8 inches inside diameter.

We then get:

Formula (1)

$$t = \frac{4000}{8000} \times 4 = 2''$$

Formula (2)

$$t = \left(e^{\frac{4000}{8000}} - 1\right) \times 4 = 2.596''$$

Formula (3)

$$t = \left\{\left(\frac{8000 + 4000}{8000 - 4000}\right)^{\frac{1}{2}} - 1\right\} \times 4 = 2.928''$$

Formula (4)

$$t = \frac{4000}{8000 - 4000} \times 4 = 4''$$

On the basis of this Prof. Reuleaux's statement seems somewhat surprising, because, if his statement is true, we should expect to find the largest result given by formula (3).

The writer has developed the following equations, which give a very interesting comparison, and which he has not seen elsewhere:

Formula (2)

$$\frac{t}{r} = e^{\frac{p}{s}} - 1 = \frac{p}{s} + \frac{1}{2}\left(\frac{p}{s}\right)^2 + \frac{1}{6}\left(\frac{p}{s}\right)^3 + \frac{1}{24}\left(\frac{p}{s}\right)^4 + \ldots.$$

Formula (3)

$$\frac{t}{r} = \left(\frac{s+p}{s-p}\right)^{\frac{1}{2}} - 1 = \frac{p}{s} + \frac{1}{2}\left(\frac{p}{s}\right)^2 + \frac{1}{6}\left(\frac{p}{s}\right)^3 + \frac{1}{24}\left(\frac{p}{s}\right)^4 + \ldots. \text{ (approximately)}$$

Formula (4)

$$\frac{t}{r} = \frac{p}{s-p} = \frac{p}{s} + \left(\frac{p}{s}\right)^2 + \left(\frac{p}{s}\right)^3 + \left(\frac{p}{s}\right)^4 + \ldots.$$

It must be noted that in the equation for formula (3), fractions are left out from each member on the right-hand side of the = mark, which causes (2) and (3) to appear alike; but to make this article plain, the writer has avoided giving the mathematical work, as far as possible.

To show the difference between equations (2) and (3), I will give the more correct equation:

$$(3a)\quad \frac{t}{r} = \left(\frac{s+p}{s-p}\right)^{\frac{1}{2}} - 1 = \frac{p}{s} + \frac{1}{3}\left(\frac{p}{s}\right)^3 + \frac{1}{5}\left(\frac{p}{s}\right)^5 + \frac{1}{2}\left\{\frac{p}{s} + \frac{1}{3}\left(\frac{p}{s}\right)^3 + \frac{1}{5}\left(\frac{p}{s}\right)^5\right\}^2 + \frac{1}{6}\left\{\frac{p}{s} + \frac{1}{3}\left(\frac{p}{s}\right)^3 + \frac{1}{5}\left(\frac{p}{s}\right)^5\right\}^3 + \frac{1}{24}\left\{\frac{p}{s} + \frac{1}{3}\left(\frac{p}{s}\right)^3 + \frac{1}{5}\left(\frac{p}{s}\right)^5\right\}^4 + \ldots.$$

But it must be remembered that even in (3a) the higher powers of the fractions $\frac{p}{s}$ are left out, and this continued farther will give equation (3), which is shown in that shape so as to better illustrate the surprising similarity between the two formulas (2) and (3). The influence of these fractions thus left out from equation (3) is shown in the accompanying table.

An examination of these three equations will clearly show the difference between the three formulas in question, and also that formula (1) appears as the first member in all of them.

Prof. Reuleaux in his "Konstrukteur" also gives us the formula:

$$\frac{t}{r} = \frac{p}{s}\left(1 + \frac{p}{s}\right) \qquad (5)$$

This formula is intended to be used for low and medium pressures, and may also be written

$$\frac{t}{r} = \frac{p}{s} + \left(\frac{p}{s}\right)^2,$$

and in this shape it will easily be recognized as the first two members of my development of formula (4). Remembering that p must always be smaller than s, and thus $\frac{p}{s}$ must always be smaller than 1, we will at once see that the higher powers of $\frac{p}{s}$ must add a comparatively small amount to the thickness, and thus as compared with (4) formula (5) should be near enough for all practical purposes.

Trautwine gives the following formula:

$$\frac{t}{r} = \frac{p}{s}\left(1 + \frac{p}{2s}\right) \qquad (6)$$

which he quotes from Reuleaux's "Konstrukteur," but which in the fourth edition of the "Konstrukteur" is corrected to our formula (5), as given above. I mention this formula (6) because, given the shape

$$\frac{t}{r} = \frac{p}{s} + \frac{1}{2}\left(\frac{p}{s}\right)^2,$$

we will at once recognize it as the first

$\frac{s}{p}$	Values of $\frac{t}{r}$							Cast Iron of 18000 lbs. T. S.	
	$\frac{p}{s}$ (1)	$\frac{p}{s}\left(1+\frac{p}{2s}\right)$ (6)	$e^{\frac{p}{s}}-1$ (2)	$\left(\frac{s+p}{s-p}\right)^{\frac{1}{2}}-1$ (3)	$\frac{p}{s-\frac{2}{3}p}$ (7)	$\frac{p}{s-p}$ (4)	$\frac{p}{s}\left(1+\frac{p}{s}\right)$ (5)	p in lbs. at safety of 5. A	p in lbs. at safety of 10. B
1.667				1.0000	1.0000			2160	1080
1.750				.9166	.9230			2057	1029
1.875				.8126	.8275			1920	960
2	.500	.625	.6487	.7320	.7500	1.000	.7500	1800	900
3	.333	.389	.3956	.4142	.4286	.5000	.4444	1200	600
4	.250	.281	.2840	.2910	.3000	.3333	.3125	900	450
5	.200	.220	.2214	.2247	.2308	.2500	.2400	720	360
6	.167	.1806	.1813	.1832	.1875	.2000	.1945	600	300
8	.125	.1328	.1331	.1339	.1363	.1428	.1406	450	225
10	.100	.1050	.1051	.1055	.1071	.1111	.1100	360	180
12	.083	.0868	.0869	.0871	.0882	.0909	.0902	300	150
15	.067	.0690	.0689	.0690	.0697	.0714	.0711	240	120
20	.050	.0512	.0512	.0513	.0517	.0526	.0525	180	90
25	.040	.0408	.0408	.0408	.0411	.0416	.0416	144	72
30	.0333	.0339	.0339	.0339	.0341	.0344	.0344	120	60
40	.0250	.0253	.0253	.0253	.0254	.0256	.0256	90	45
50	.0200	.0202	.0202	.0202	.0203	.0204	.0204	72	36
60	.0167	.0168	.0168	.0168	.0168	.0169	.0169	60	30
100	.01000	.01005	.01005	.01005	.01006	.01010	.01010	36	18

CYLINDERS UNDER INTERNAL PRESSURE.

two members of my development of formulas (2) and (3).

Formula (3) is the one mostly used for high pressures, and is given by Kent, Trautwine, Unwin, Reuleaux and Fowler; but for ease of figuring the writer will suggest and also uses the following formula:

$$\frac{t}{r} = \frac{p}{s - \frac{2}{3}p} \qquad (7)$$

It will be found to give nearly identical results with formula (3), and the very slight variation will altogether be on the safe side.

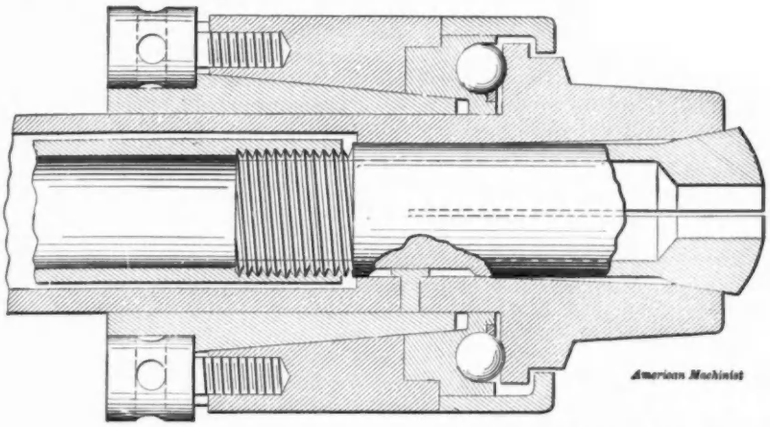
The table given on the preceding page will also prove very interesting. It shows the ratio $\frac{t}{r}$ figured by the different formulas quoted here, arranged so as to make comparison easy.

Columns A and B give the internal pressures p at a safety of 5 and 10, respectively, if we assume the ultimate tensile strength of cast iron as 18,000 pounds per square inch. The writer is aware that much better iron would be used, especially for high pressures, but uses this low value purposely.

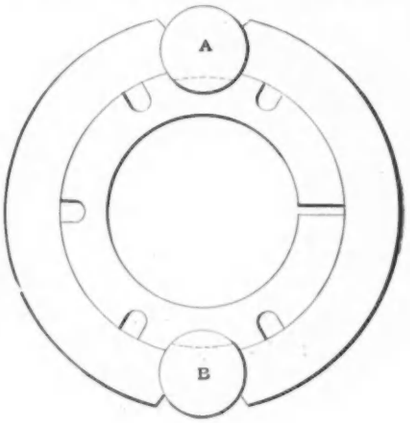
We can from this table get an idea of how far we can use the simplest formula (1). Formula (2) and the formula given by D. K. Clark may be left out of consideration. The more easily applied formula (7) shows very nearly the same thickness as the more complicated formula (3). Thus, assume from column A an internal pressure of 1,800 pounds per square inch and a diameter of 20 inches, which will give us a thickness of 7.5 and 7.32 inches, respectively, from formulas (7) and (3), showing a difference of only 3-16 inch under these extreme conditions, combining a large diameter, high pressure and a weak iron. We may also note the difference between formulas (4) and (5) and the difference between (3) and (5), which last seems rather remarkable, as Prof. Reuleaux in his "Konstrukteur" recommends formula (5) for lower pressures only.

We will also see the rather small differences that exist between all seven formulas when the pressures are low, and especially if we can figure on a high tensile strength of the material. In this case we also have to add a constant, not only to make up for cores getting out of center in cast cylinders, but often so as to get dimensions that will allow of being handled without breaking or getting out of shape or be rigid enough for turning and finishing.

Dayton, Ohio.

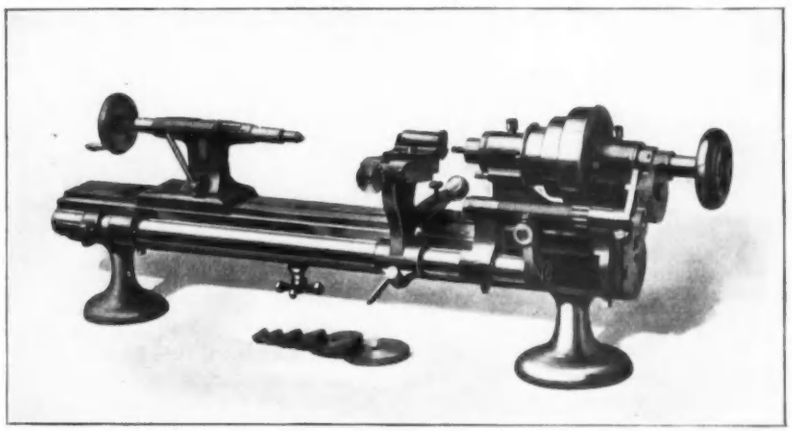


SECTION OF SPINDLE AND CHUCK.



Improved Bench Lathe.

The Cataract Tool and Bicycle Company, of Buffalo, N. Y., has recently perfected a fine bench lathe having some interesting features, and which we show in the accompanying illustrations. In its general features the lathe does not depart radically from the standard construction, but it is made with heavier bed and headstock than is common, to adapt it to a little heavier work and to give stiffness and freedom from vibration. The bed of the machine here shown is 32 inches long, and it is faced and slotted behind to adapt it for taking the various attachments. The planing and scraping are done to standards, so that fixtures placed upon the bed are strictly interchangeable and always come in the proper position. The spindle is of hardened steel throughout and runs in a form of bearing which was devised some years ago by Mr. Church, the mechanical superintendent of the American Waltham Watch Factory, in which factory this bearing has been in continuous use for about three years, giving entire satisfaction. The journal is cylindrical and runs in a bushing composed of cast iron, which is conical, externally split and channeled, so that by means of the filister head adjusting screws, shown in the longitudinal section of the bearing, all lost motion may be readily taken up. The taper sleeve is, of course, very carefully reamed and lapped, and it is found that in use it acquires a hard, glazed surface, which is very durable; the bearing holds the spindle solidly, and adjustment can be made without disturbing the alignment of the spindle. The longitudinal section shows the bearing fitted with ball thrust, which, in combination with the cylindrical bearings, makes an easy and simple way of taking care of the end thrust, and makes the lathe run very freely. It is also made, however, without the ball thrust, the bearing itself remaining much the same and thrust being taken on a plain collar at the front of the main bearing.

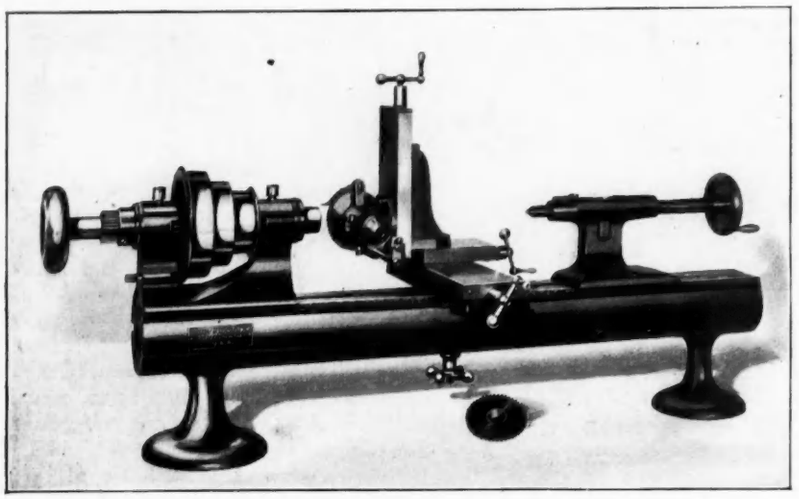


REAR VIEW OF CATARACT BENCH LATHE, WITH THREAD CHASING ATTACHMENT.

The lathe is of 7 inches swing; the spindle admits of ½-inch stock passing

through it, and its mouth is ground for the chucks to an angle of 12 degrees. The cone pulley is for a 1-inch belt, has two rows of index holes in the back flange (60 and 48), either of which may be used by means of an eccentric index pin. The front face of the pulley also has four holes, so that by means of a push-pin the spindle is held while chucks are opened and closed without the necessity for using the index pin for that purpose.

The tailstock spindle is made quite long, passes entirely through the tailstock, so that it has a full-length bearing at all times; is graduated on top, and the graduations are read through an opening in the top of the tailstock, there being also micrometer graduations on the hub of the wheel for fine adjustment.



FRONT VIEW OF CATARACT BENCH LATHE, WITH MILLING ATTACHMENT.

We show the machine with milling attachment on the bed, the construction of which will be readily understood. The spindle is elevated or depressed to any required angle, graduations being provided for setting it. There is an extension center for supporting the outer end of the work, which is held in a standard split chuck, and index wheels are provided for any ordinary divisions required.

The second photograph gives a rear view of the machine, with chasing attachment in place. This attachment does not require a change of hob when different pitches are to be cut, but the same hob is driven at various speeds to give the required pitch.

This attachment is, of course, very similar to that used on brassworkers' lathes, and enables threading to be done very rapidly. It is intended to be used with disk cutting tool.

The slide rest is not shown, but is in general appearance similar to those used on this class of lathe, having the usual upper and lower slide, the upper one of which can be swiveled to any desired angle without disturbing the position of the lower slide, which remains at right angles with the center line of the lathe, there being a shoulder provided for bringing it into alignment by contact with the front edge of the bed, but by drawing the lower plate back a little it also can be set at any desired angle. The traversing screws are of tool steel, running in hardened and ground bearings, are provided with disks having micrometer graduations, which are fitted to the screws on a taper, so that they are held by friction and may be adjusted to zero when the screws are in any position.

This slide rest is, when desired, fitted with the usual telescopic shaft arrangement for cutting screws by means of change gears in the regular way.

The lathe is provided with all the usual attachments, including turret grinding attachment, inside threading attachment, etc.

The Latest Patented Air Compressor.

BY FRANK RICHARDS.

It has come in my way of late years to know something generally of what is going on in the developing and improving of compressed air practice. If I do not catch on to the things myself, some of my friends are sometimes kind enough to call my attention to matters of interest or novelty in this line as they come along, for which attentions I thank them all. It thus happens that I have before me a copy of the latest patent for an air compressor.

The drawing accompanying the patent, which I trust will be kindly reproduced here, shows, without labored explanation, how this air compressor works. You have a running shaft at the top of an inclined plane, with a drum upon it and a clutch by which the drum may be engaged or released. Around the drum is wound a rope, chain or string, the end of which attaches to a loaded car upon an inclined track, and when the clutch is engaged the car is hauled up the incline. At the rear of the car is attached a rigid rod parallel with the track, or with the normal line of travel of the car. This rod is in fact a piston rod, with a piston at the lower end of it. Below the track, and with its axis parallel to it, is placed a hollow cylinder, its lower end closed and its upper end open and flaring, so that the piston when it descends will not miss it. At the lower end of the cylinder is a passage or pipe connecting it with an air receiver or tank, and at the receiver end of this pipe is a check-valve whose business it is to see that what air comes into the receiver can never return by the same passage. At the lower end of the cylinder is placed also another valve opening inwards. This is all there is of it, at the beginning, and it is not easy to imagine anything more simple. You throw in the clutch and the car and the piston go up the incline. You throw out the clutch and they descend; the piston goes down into the cylinder with a chug, and the air flees before it into the reservoir, where it is held from returning by the check-valve.

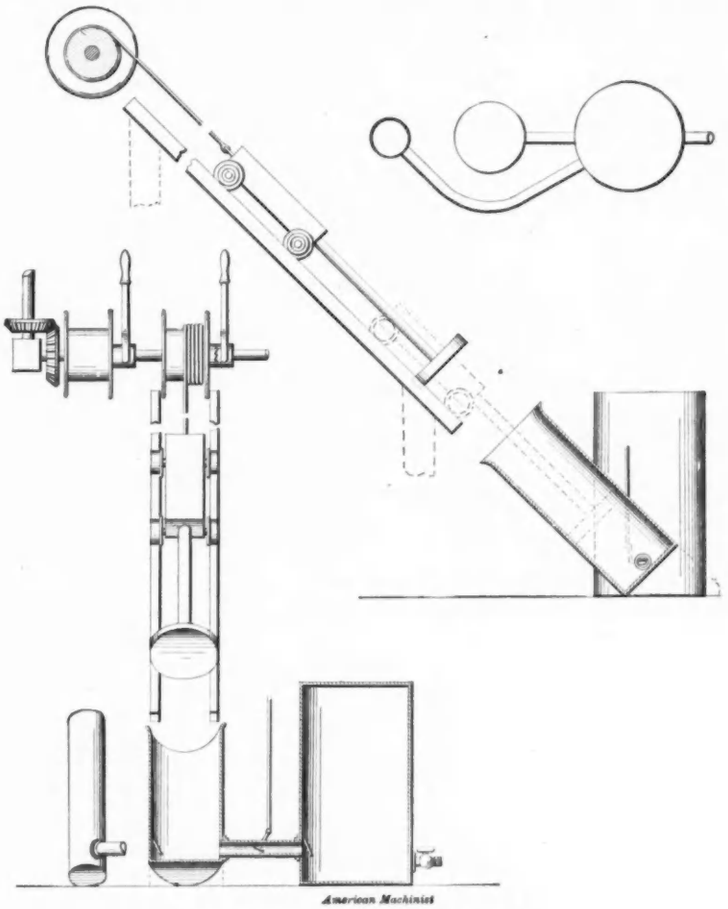
Now, of course this apparatus will work. Some things when you look at them you know will not work, even if they are patented. Some other things you have serious doubts about, and you will not be satisfied until they are tried; but this air compressor certainly will compress air. The smaller cylinder, seen at the left in the lower figure, is intended to be used in case the other cylinder works too well, or delivers too much air. It is to have its own car, piston, string and all that, the same as the other, only the drum and clutch for it being shown. The passage from the small cylinder to the air receiver can run around the other cylinder, as shown in the plan up at the right.

In putting this compressor in operation some care is necessary on the part of the operator. If the car is hauled to the top of the incline and then let go, the piston will strike the bottom of the cylinder with a thud anything but dull, on account of the lack of resisting pressure in the air receiver. To prevent any trouble of this kind we have the "regulating" valve in the middle of the pipe or passage between the cylinder and the receiver. This valve is operated by the long vertical handle or rod. The passage is partially closed by the valve, and enough air is retained in the bottom of the cylinder to properly cushion the piston. As the pressure accumulates in the receiver the regulating valve may be gradually opened, and when the compressor is in full operation at full pressure, the valve has nothing more to do.

There are those who will be ready to suggest that this valve might have been dispensed with. Things might be started with the car unloaded, and then weight might be added to it as the pressure increased. Perhaps the handiest way would be to have the body of the car a water tank, and then a fellow could stand alongside with a hose and squirt water into it. The final chug of the water against the

lower end of the tank should be a help to the piston as it fetched up against the air. If the compressor was used only by day, and if the tank leaked enough to let all the water out over night, it would be all right for beginning compression again in the morning.

It would make quite a difference in the operation of this compressor as to the pressure to be maintained. An air compressor, as we all know, has to perform two easily separable operations—first, the compression of the air to the required pressure, and, second, its expulsion from the compressing cylinder and its delivery into the receiver. The descent of the car and piston for a given distance would give



THE LATEST PATENTED AIR COMPRESSOR.

a constant total force, and this might be just right for the compression and delivery of the contents of the cylinder at a certain pressure. The compression in any case must precede the delivery. Then if the pressure increased, although the air might be compressed to the required pressure, it could not be all delivered, and the pressure might be so increased that there would be practically no delivery. In any case the elasticity of whatever air remained in the cylinder would cause a rebound of the piston, a slacking and a possible tangling of the string, and a loss of all the force expended for the compression of this portion of the air.

In suggesting that the operation of this compressor might not be altogether satisfactory, this does not imply that the fault is in the compressor or in its inventor. The fault very distinctly is in the air, and not in the compressor. As the inventor of the compressor had nothing to do with designing the air he cannot be held responsible for its action. There are those who, when about to design any machine for any purpose, take pains to inform themselves as to what they have to operate upon, what are the conditions that must be satisfied and that cannot be evaded. Where air or water or any of the elementary materials are to be operated upon, some inventors ascertain how these things insist upon acting under various conditions. But the most numerous class, and the class most successful in obtaining patents for alleged inventions, seems to be composed of "original" and "independent" inventors. Surely nothing can so insure originality as utter ignorance of all that others have done, and how they have done it, and the independence which ignores Nature as well as man can scarcely be developed further.

The patent office was avowedly established for the promotion of useful inventions, and the present "invention" is certainly a useful one, according to the definition of usefulness accepted in Washington, for it is apparently quite harmless, and so the usefulness of the patent office is again vindicated.

Letters from Practical Men

The Future of the Blacksmith.

Editor American Machinist:

I have several times lately found myself questioning and wondering about what is to become of the blacksmith, and the letter of "Florin," in your issue of February 8, about "The Blacksmith Who Had Graduated," has given my mind an additional shove in the same direction. The history of the blacksmith is a long and a strange and a most honorable one. "Old Tubal Cain was a man of might in the days when Earth was young." The smith's fire illumines the first page of history, and the ring of his anvil is the remotest sound we hear. We boast in these days of our steel armor, our weapons offensive and defensive, our ships of war and the engines that drive them, and we argue that never was the worker in iron and steel so entirely the military backer as now; but surely in the beginning of things the same was just as true. The smith made the first swords and shields and coats of mail, and before he made the plowshare. The weapons of war he made before he made the simplest machine, but the machine was his later product, and the machinist is one of his lineal descendants. The same man in the beginning worked the metals in both the plastic and the liquid states, so that the foundryman is also another original smith.

But what is troubling us now is the change in the status of the blacksmith since the subdivision and separation of his primitive work and the full establishing of his successors and partners, the machinist and the molder. At the beginning of the century, and up to the middle of it, the machine works of the time embraced a trio of shops, the machine shop, the foundry and the blacksmith shop, and if it was a steam engine works there was also the boiler shop, another distinct outgrowth from the original blacksmith shop. These shops all flourished side by side, and at the beginning it certainly could not have been said that the blacksmith shop was the one of least importance, or that a blacksmith was less skillful than a machinist or a molder. But we all know how things have changed. The machine shop has been growing continually, and has itself sprouted and subdivided. The trade is now too big for any one man to fill it, and when we are told that any man is a machinist we have next to inquire what is his line. The builder of the marine engine cannot build the linotype machine, or *vice versa*. The molder, too, has developed more skill and reliability, and the field of his employment also has widened, but the work of even the latter-day blacksmith has largely gone from him. What with steel castings and malleable castings and wrought-iron castings and drop forgings and bar iron and steel of special shapes and sizes, the blacksmith has become a picker up of odd jobs, with the jobs few

and far between. The fellow who could say that it didn't take any brains to be a blacksmith was all right if he meant that it requires no brains to do nothing. For the one thing that the blacksmith still has to do, the forging of tools and the tempering of them, there was never greater skill required than to-day. There is less forging of tools as we go along, of course, but there is more annealing, hardening and tempering to be done than ever before, and in none of the industries, perhaps, does the highest skill leave something to be desired more frequently than in the men who temper our tools. Complaints of tools that crack or warp in hardening, or that do not stand up to the work as required, are by no means infrequent, so that brains are still required by the blacksmith, and in the narrowed sphere that just now seems to remain to him the most alert brain is still none too good.

As to the recovering of the old prestige of the blacksmith, and the re-enlarging of his sphere to its pristine dimensions, that may or may not be. There are at least two things for the blacksmith to do. He may either accept the situation as it is, or he may get up and make new lines of work for himself. Nobody that is anybody, or who is to be anybody, ever does the first. The continual non-acceptance of things as they are is what shoves the world along. But it makes all the difference which way you get out, and the only winning way is to climb out at the top. Sneaking out at the side or the back leaves one on the same level as before. You can bet that the fellow who found little use for his brains in the blacksmith shop carried little brains into the bicycle repairing and lawnmower work. There are plenty of young fellows, and old ones, too, who are dissatisfied with their positions. There are stenographers and typewriters so lofty that they can't produce a perfect letter for you. Edison climbed out at the top of the telegraph business by being perfect as he went along.

So many have climbed out at the top of blacksmithing that it may just now seem lonesome. There are, I doubt not, some of the old brains still working in the craft, and I expect to hear from them. It is not for me to suggest the lines of future occupation and development. We don't see or hear much of the line of work in which the blacksmith used to excel. He was once an artist, and why not now? The photographer and the engraver have not killed the painter or the sculptor, and neither should machine work drive out the handiwork of the smith. All the instruments of Keuffel & Esser cannot be made to draw a line as the human hand can draw it, and all the lathes and planers and milling machines and what not cannot do what the blacksmith's hammer can do. There is a vast field open for the individual blacksmith (with brains) in decorative art work. Someone will be making a break one of these days in the finishing of our buildings. Our big buildings are now anything but structures of stone or of brick, and yet we must still pretend that they are made of the old-time materials, and we waste lots of money in carrying out the deception. We will yet get so far away from brick and stone in our building that we will scorn to seem to imitate them, and then the blacksmith may have his innings.

TECUMSEH SWIFT.

More Patents for Liquid Operated Tools.

Editor American Machinist:

I enclose a description of two patented machines in which the tool-holders are moved hydraulically. These are special machines, but as far as the hydraulically operated movements are concerned, they might be adapted for general work.

The patent to R. R. Spears, No. 615919, Dec. 13, 1898, while not describing a "machine tool," inasmuch as the machine of said patent is adapted only for special work, viz., turning carriage axles, nevertheless is analogous to the machines already described, in that it has a reciprocating tool-supporting carriage driven by a piston connected thereto, the cylinder being bolted to the rear end of the bed. A piston valve, controlling the admission and exhaust at both ends of the cylinder is operated by tappets on the carriage. In order to get a rapid feed of the tool-holder up to the work and then a slow feed while the tools are cutting, two of the tappets are made with inclined cam surfaces operating on a lever to partially close the valve.

Another special machine in which the tool-holders are moved into and out of operative position by hydraulic mechanism is the "machine for turning steel tires for railway wheels," patented by William Sellers, August 25, 1896, No. 566702. The face-plate of this machine, to which the tires are clamped (also by hydraulically operated mechanism), is horizontal, the tools, when operating, being supported over the face-plate. In order to facilitate removing the finished tire and replacing it with an unfinished one, the tool-holders, four in number, are supported on frames or arms, adapted to swing through 90 degrees in a vertical plane, so as to carry the tool-holders entirely out of the way, without changing their radial distances from the center of the face-plate. The swinging of these arms is performed by means of a stationary piston and movable cylinder, the latter being connected to levers which in turn are connected to the frames or arms. The water passes through two passages in the piston-rod, one communicating with the cylinder on one side of the piston, and the other on the other side. The pressure is continuous on the small or rod side of the piston and intermittent on the other. The chucking devices are hydraulically operated by radial cylinders for the exterior clamping jaws and by a vertical cylinder carrying wedges for the interior centering and clamping jaws. No special valve mechanism is intended to be manually controlled.

H. A. COOMBS.

Tapping Holes—The Tap Guide.

Editor American Machinist:

The description of the tap gage shown in the "American Machinist" for January 25 reminds the writer of an incident of which he was never particularly proud. A number of years ago, while working in a locomotive repair shop, I was given the job of tapping out the steam chest stud-holes of a pair of new cylinders that had been put on a locomotive to replace those broken in a wreck. The cylinders were of peculiar design in some respects, and the room between the inside row of stud-holes and the saddle was so limited that nothing but a single-ended tap wrench could be used, and even that could be used only at considerable disadvantage. To add to the difficulties, the space between the raised valve seat and the saddle was so short that a square could be set to keep the tap square in only one direction. The troubles mentioned are those that were quite apparent at that time, being greatly magnified on account of my inexperience. After tapping one or more holes and finding that a stud screwed into the hole stood at an angle of something like that of the famous leaning tower of Pisa, I conceived the brilliant idea of using the angle-iron scheme shown by your correspondent. In this case, however, no attempt was made to closely confine the tap in the guiding hole, but the angle iron was drilled with a hole large enough to admit the thread of the tap, so that the different taps of the set could be used without loosening the angle iron until the hole was tapped. The angle iron was so clamped that when the tap was inserted in the hole to be tapped and the shank brought against the side of the guiding hole in the direction of the pull of the wrench, the tap would stand square.

In this way the remainder of the holes were tapped in quite a creditable manner for a greenhorn, but the sarcastic remarks directed at the inventor (?) of the device were not at all comforting, and the rig was never used again.

I found that the tapping of holes squarely and quickly is a knack that comes with experience, and that even in peculiar and difficult places there is rarely one that renders any guiding device necessary. When tapping with a single-ended wrench in places where the direction of pull cannot be varied and it is difficult to support the tap with the hand, the tendency of the tap to lean in the direction of pull can be overcome by lifting on the handle at the same time, thus counteracting the effect. While it might be argued that the direction of one force is at right angles to the other and in a different plane, the writer knows that it will, in practice, overcome the difficulty mentioned.

When tapping cast iron it is quite a common practice to never use oil, for the same reason that oil is not used when drilling cast iron, but I always found that a small quantity of oil judiciously used was a considerable labor saver, and that taps remained sharp longer when oil was used. Again, I have found, when tapping holes by hand in cast iron, that it is not necessary to use the three taps of a set, even where the holes are shallow, and am inclined to think that the taper tap is more of a nuisance than a necessity. A hole can be started squarer, and kept so, with a plug tap which is properly ground than with the ordinary taper tap. The thread is cut easier, there is not nearly as much danger of getting it bell-mouthed, and time is saved by using only two taps instead of three. In fact, considerable, if not all, work that requires stud or tap-bolts can just as well be drilled so that only the plug tap need be used, and thus save one operation. A stud should always be threaded so that it will not bottom in the hole, but will wedge in the taper of the thread at its termination, thus making the drilling of holes deep enough for the plug tap feasible in most cases.

Newark, N. J. F. EMERSON.

Keeping the Cost of Tool Work.

Editor American Machinist:

Having read with interest in your issue of January 18 the article by A. P. Press on "Keeping the Cost of Tool Work," and in response to his invitation I submit for his consideration and others interested the system I have adopted. The conditions under which it is used here are these:

On all new work an order is issued to the department by the superintendent, having a number. The article for which the tools are to be made has a catalog number, and blueprints are furnished, also having a number, which are filed and become, after the completion of the job, a part of the records of the department.

On all repair work orders are issued by the foremen of the respective departments, which are numbered, the number being preceded by letters which designate the department and division issuing them. Each employee has a time check number. Fig. 1 represents a card to which each employee's time is transferred from the daily time card, and which gives at the end of the month each employee's time and its distribution.

On the completion of a job all of the totals chargeable are transferred from the cards represented in Fig. 1 to Fig. 2, which give the cost of labor. Material is obtained from the stock department on orders, duplicates of which are kept, furnishing the data for this item. The cards shown in Fig. 2 are indexed by order number, and a cross index for the catalog numbers furnishes a reference that is as nearly instantaneous as circumstances have so far demanded.

The cards shown in Fig. 1 can be footed up at the close of the month at the rate of about ten per hour, and those shown in Fig. 2 average about ten minutes each, while the transferring of the time from the daily time cards to Fig. 1 can be done while the boys are washing up after the whistle blows.

The actual rates are quite as easy to figure as a horizontal one by making a table showing the hardest ones to compute. This, it seems, would give actual rather than nominal cost.

Milwaukee, Wis. I. N. DOLPH.

DIE DEPARTMENT.

Name H. Webster Check No. 499

Month OCT - - 1899 Rate .30

Order No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total Time	COST.	
01493		1																														1		30
01552		9	10	10	10	10	9		10	10	10	10	10	9½	5																	123	36	90
01559															5	10	10	10	10	9½	10	10	10	10	10	1						95½	28	65
01594																											9					9	2	70
CR393																												9½		1		10½	3	15
																																239	71.70	

FIG. 1. EMPLOYEE'S MONTHLY CARD.

3314-15 Cat' No. Head Cups Order No. 01552

Tools for Making Head Cups # 3314-15

as per Blue Print D-19

Blue Print D-19 No. of Operations 6

MATERIAL USED						LABOR						
No. Pieces	DESCRIPTION	Dimensions	Weight	Price	COST	Emp. No.	From	To	Hours	Min.	Rate	COST
7	Tool Steel	2"	33½	12	4 02	499	10/2	10/16	123		30	36 90
3	" "	3"	5¾	13	75	468	10/3	10/5	21		22½	4 72
3	" "	4"	42	13½	5 67	470	10/4	10/17	20		25	5 00
2	Machine "	2	4	.03	12	477	10/3	10/11	43	30	10	4 35
Totals					1056							50 97

Grand Total $ 61.53

FIG. 2. JOB CARD.

Mechanical Practice in the North of England.

Editor American Machinist:

An American traveler and writer once noted that the largest shipbuilding trade in the world was carried on along the banks of the Clyde, a mere muddy ditch of so small a width that the building slips all required to be pointed at an angle down stream, because the Clyde is too narrow a stream in which to launch direct. Very much the same thought occurs to one here at Hartlepool, in Durham County, on the northeast coast of England. I had always heard much of Hartlepool as a shipbuilding port, and naturally went out to look for some signs of it; and I found it. Here the class of ships built is largely that of the tramp. A tramp steamer is one of cheap construction, large carrying capacity and moderate engine power. Such steamers may be seen in every quarter of the globe, jogging along at a moderate speed of 8 knots, using a minimum of coal, and not presenting, perhaps, too pleasing an appearance. One shipyard in Hartlepool, for two years in succession, launched a tonnage greater even than that launched by the famous firm of Harland & Wolf, in Belfast. The latter firm have only succeeded in heading the list this year owing to the launching of the "Oceanic," the tonnage of which placed them again at the top.

Ships in Hartlepool are built very much as on the Clyde, prepared for launching upon narrow waters. At one yard, where three large steamers were in various stages of construction, the water was at the time of my visit at low tide, and the basin into which these vessels would ultimately be launched was little better than a small

pond. Launching is thus deprived of any poetry it may once have possessed. Ships are built rapidly and pushed as soon as possible into the water with little ceremony. They voyage about unheard of for many years, and finally disappear, but they are stout and good ships, steel built, and serve their purpose. Only a few years ago Hartlepool was a very small place—a mere fishing village. Now it is a place of about 70,000 people, and carries on a large trade in timber with the Baltic and Norway, as well as the big shipbuilding business, and it is curious to note that only a very few years ago the leading men in the two largest shipyards were, respectively, a draper and a grocer. It is of course the iron industry of the Cleveland district, as the district is called of South Durham and North Yorkshire, that has rendered Hartlepool possible. Being new, there is more push about the place than one finds in older districts. Compared with Staffordshire, with its old plants and wrecked buildings, and its unwholesome fear of tearing out obsolete stuff, this district is an agreeable contrast. An ironworks near here has practically rebuilt itself, and put itself abreast of modern conditions. No Staffordshire manufacturer ever seems to reconstruct anything. Works there die of old age and over-fat fortune making, but they are not even dismantled. The old plant is left to rust away, and there are to-day in Staffordshire thousands of tons of old iron going back to oxide, and there are old furnaces and buildings left standing in a way that gives perhaps an appearance of decay that does not really exist, for the iron industry is very busy in Staffordshire, as well as in every other place. Indeed, business generally is so busy all over the country that it is difficult to procure coal, the railways are choked with traffic, and iron, steel and machinery are only to be got after months of delay. It is only when one comes into the northern counties that one finds the energy I note here. Everything marks progress that is absent in the south.

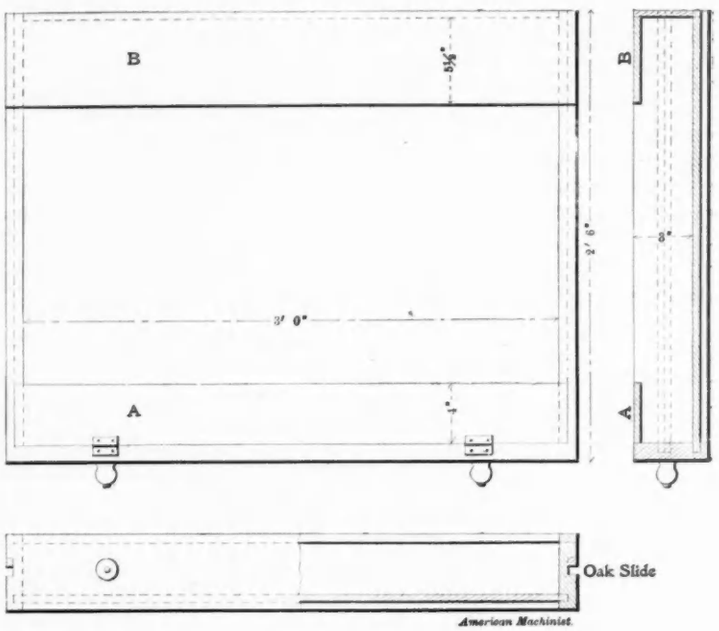
It is curious to note the differences in practice which circumstances compel. It is well known that British locomotives have been tied to size by the dimensions of tunnels constructed many years ago. These, and the bridges, fixed the limit of hight of chimney top, and it would never have done, at one time, to build a locomotive without a well-proportioned chimney. Hence boilers, then small, were kept low, and an engine with inside cylinders was quite inaccessible, as regards its valve gear, from above. But the exigencies of trade have compelled great alterations. Locomotive boilers have been made very much larger in diameter, and at the same time have been placed very much higher up. At York I saw one of the later express passenger engines of the Lancashire & Yorkshire Railway. The middle of the boiler was as high as my head as I stood on a platform nearly 4 feet above the rail. The barrel of the boiler was so large that the funnel, of regulation hight above the rail, only projected a few inches above the boiler crown. The dome projection was a mere hemisphere upon the boiler, while the cab was only an inch or two higher than the top of the straight-topped firebox. The valves were above the cylinders and had the Joy gear, and everything was as accessible from the top as if no boiler had been there. The coupled wheels are, I believe, 90 inches in these engines, which present a most unusual appearance and represent the fullest attempt to obtain requisite dimensions and power, with convenience in handling and repairs, without any sacrifice to the fancied appearance once thought necessary in a funnel. The engine is not a beauty, but it looks eminently business-like, and as regards its general dimensions is probably as large and heavy as any locomotive of the eight-wheel class of express type in the world. But the dimensions have only been possible by entirely putting aside every consideration of appearance, cutting down the hight of the chimney, the dome and the roof of the cab, as demanded by the limit of the structures through which the engine must go. As these engines are quite satisfactory, it is evident that a long chimney is not necessary to the success of the steam blast draught. The keeping low of the cab roof is a step in the right direction, for too much of a projection is only so much hindrance to the passage of an engine through the air.

W. H. Booth.

Storing Drawings and Patterns.

Editor American Machinist:

Mr Crocker's "System of Marking and Storing Drawings and Patterns" was very interesting to me, for I am anxious to get a better system than I am now using. I want my drawings and patterns so classified that anyone can go to the drawing cabinet and find any drawing, or to the pattern house and find any pattern without the aid of a clerk. Clerks for this particular purpose cannot be afforded, except by large companies; and even when they can be employed they are not always just where they are wanted, or there will come at the same time to the same clerk three or four men, wanting entirely different drawings, and neither has the time to wait until the clerk has found the drawings for the other. They all know the subject of their respective desired drawings, but neither knows the number of the drawing he wants. For the above reasons I would never advise the numerical classification of drawings and patterns. By this system room is saved, but such a saving of space is too expensive ever to be allowed.



DRAWER FOR DRAWINGS.

Everyone that wants a drawing knows the subject of it, so we have classified our drawings by subjects. We have a drawer for each subject, and two extra drawers for miscellaneous drawings. On the front of each drawer is plainly written the general subject of the drawings to be kept in that drawer. We have only twenty-four drawers, and have ample room for about 400 drawings that we now have on hand and as many more yet to be made. With this system of storing drawings any person that can read writing can find a drawing with but little trouble. While we never allow drawings to be taken from the drawing room without a record of the number and subject of the drawing, the date it was taken out, the drawer taken from and the person by whom taken out, every foreman is allowed to come to the

drawing room and examine drawings and return them to their respective places.

On each drawing is stamped the number of the drawer in which it is to be kept, so there is no chance of mistake in returning them to the drawers. We have our drawings numbered consecutively as they are made, but in no case are they classified by numbers. We have an index of the drawings arranged numerically as they are made, with the subject of the drawing and date of its completion, so if anyone should be in doubt about the classification of a drawing, but knows about the date of its completion, or happens to know its number, he can find it without much trouble.

Our system of storing patterns is exactly the same as that of storing drawings. With this system there seems to be confusion when a pattern has to be used for more than one purpose; but we prevent such confusion by keeping a drawing for this pattern in with each set of drawings of the different things requiring the use of such a pattern. This enables anyone to always find the drawing. On each drawing is plainly marked the name of the first object for which the pattern was used and the number of the pattern, and as our patterns are always kept with the patterns of the first thing they were used for, anyone having the drawing knows at once where he will find the pattern.

It might be well to give here a sketch of the drawers to our drawing cabinets, which are greatly admired by all those who see them. This drawer may appear very old and out of date to some of the more advanced draftsmen; but I have yet to see the drawer that suits me better. In the sides of these drawers are grooves with oak strips, as shown on the accompanying sketch, for slides which run on the guides in a boxed frame. The boards *A* and *B* are the parts to which I wish to call attention. The board *B* is rigidly fastened on the back of the drawer as shown. The front board *A* is hinged, so that it can be turned back. To put in the drawings the front board is turned back and the drawings are pushed under the back board until the front edge of the drawings will go down in the drawer. The front board is then turned down to closed position, after which the drawer may be pushed back into the frame. With these extra boards the corners of the drawings can never rise and give trouble when the drawer is to be opened. These boards seem a very simple addition to the common drawer, but my experience has been that when anyone has once tried them he never uses anything else.

Ensley, Ala. J. I BLOUNT.

On Saturday, February 17, at 8.15 P. M., at the hall of the Mechanics' Institute, 19-21 West Forty-fourth street, R. A. Fliess, E. E., will deliver a lecture on "The Development of the Automobile."

Personal.

Regarding a personal item published in our issue of the 1st inst., the E. W. Bliss Company write us that Robert J. Good has not been in their employ since August, 1893, though the item referred to might give the impression that he had recently left their employment.

Obituary.

John Hoskin, metallurgist and mechanical engineer, and president of the Abrasive Material Company, died in Philadelphia on the 4th inst. He was about eighty years old, and was a veteran who had served with distinction in the Civil War, in which he attained the rank of major.

Inquiry for Machinery.

(121) A machine is wanted for coating or treating photo and blueprint paper in continuous strips. Can anyone tell us who has built such machines or who will build them?

Blighted Hopes.

The boy was ambitious, and replied that he would like to be paid $2.50 a week to start with.

But his employer was a hard man. "I will pay you $18 a week," said this person, brusquely.

So were the boy's aspirations crushed. He could not hope ever to become a rich man after beginning his career with any such respectable salary as this.—Detroit "Journal."

New Catalogs.

The Marinette Iron Works Manufacturing Company, Marinette, Wis., sends a catalog of the Walrath gas engines, manufactured by them for electric lighting, pumping, elevators and power purposes generally. These engines are to be furnished in sizes of 4 to 50 horsepower. The catalog is 9x6 inches.

The Lincoln Iron Works, Rutland, Vt., send us their "Circular No. 92," giving an account of their stone planing machines, the largest of which has two platens, side by side, and four tool holders, and planes 100 inches wide, 48 inches high and 16 feet long. The circular is standard size, 9x6 inches.

The American Turret Lathe Works Company, Wilmington, Del., has issued a catalog of semi-automatic turret lathes, for finishing castings, built under Conradson's patents. The pamphlet contains illustrations showing the new and old style turrets, and points out the improvements that have been made. Size of catalog, 9¾x6¼ inches.

The Prentiss Vise Company, 44 Barclay street, New York, has issued its catalog No. 46. It is illustrated with cuts of the vises made by the company, which are of considerable variety, and adapted to many special purposes. Besides those already familiar, several new sizes and styles are shown. The pamphlet is 5¼x6¾ inches.

The New York Air Compressor Company sends a catalog in which are illustrated and described their air compressors, of standard sizes, actuated by steam, gas or gasoline engines, water power, etc. The catalog contains also some tables and hints for users of compressed air. It is preliminary to a larger one now in preparation. Its size is standard, 9x6 inches.

We have received from the Meriden Machine Tool Company, Meriden, Conn., their illustrated catalog and price list, for 1900, of forming lathes, forming tools and allied tools and fixtures. Among the features of the catalog is a projection drawing and detailed description of the company's improved forming tool slide. The size of the pamphlet is standard, 6x9 inches.

Manufacturers.

The Canada Steel Company is to be incorporated, with capital stock of $18,000,000.

The Pittsburgh Reduction Company has decided to erect a large plant at Montreal, Can.

(Continued on page 38.)

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Gear Wheels, gear cutting. Grant; see p. 16.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Forming lathes. Mer.Mach.T.Co.,Meriden,Ct.

Punches & dies. Wal.M.Wks.,Waltham,Mass.

D'ftsmen's novelties. D.J.Kelsey,N.Haven,Ct.

Corliss engines designed. Box 183, AM. M.

Rawhide, fibre and hard rubber gears. The Arthur Co. (See page 8.)

Light and fine mach'y to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Book "Dies & Diemaking," $1, post paid. J.L.Lucas,Bridgeport,Ct. Send for index sheet.

Machines designed; inventions perfected; cash regis. a specialty. R. M. Lee, Columbus, O.

Wanted—Soft or common steel, ⅜x1-16 in. square on edges. Address P. O. Box 109, Schenectady, N. Y.

"Brandt's Triple Expansion Gaskets" are the best for boilers. Randolph Brandt, 38 Cortlandt st., New York.

Have plant and equipment for light machines; will contract to make them in quantities. Address Knob, AMERICAN MACHINIST.

For Sale—Two geared Ferracute presses, 62 in. between uprights; little used, and in good condition. Address W. H. Mullins, Salem, Ohio.

Wanted—One horizontal cylinder boring machine, in first-class condition; size about 42 inches. Address, with particulars, to the Harrisburg Foundry & Machine Works, Harrisburg, Pa.

Institutions retiring from business having machine tools, brass and wood working machinery will find it to their interest to correspond with us. We purchase complete plants or handle them on com. C. C. Wormer Mach. Co., 55-59 Woodbridge st., W., Detroit, Mich.

The patents, patterns and special tools of a new high-grade special machine lately patented in the United States and Europe will be sold out shortly; price $25,000; 13 of these machines have been sold within 15 months and give entire satisfaction; the gross profits on same amount to $10,486; this is a splendid addition to the business of any large machine concern, as there is a steady demand for these machines. For investigation and details address Box 160, AMERICAN MACHINIST.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded; but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of

(Continued on page 38.)

(*Continued from page 37.*)

The Canasawacter Knitting Company, Utica, N. Y., has been formed; capital, $12,000.

The Bessemer Gas Engine & Clutch Company, Grove City, Pa., will double their capacity.

The Pittsburgh Opalite Tile Company will erect large works at Monaca, Pa., to cost $40,000.

The factory of the Hopkins & Allen Arms Company, Norwich, Conn., was destroyed by fire February 4.

The Meadville Malleable Iron Company, Meadville, Pa., has completed its organization; capital, $100,000.

Shelby, N. C., is to build a $20,000 cottonseed oil mill, capacity 20 tons, and three gins. The mill will be completed by July 1.

Capitalists at Waynesboro, Pa., will erect a box factory in connection with the tin plate plant building. A sawmill will be erected.

The business men of Marine City, Mich., have raised $4,000 capital for a sugar beet factory, and signed articles of association.

The Albert Spinning Company, Philadelphia, will build a mill at North Wales, Pa., for the production of cotton yarns. About 150 hands will be employed.

Kinsig & Norris, of Glenrocks, Pa., have purchased four acres of ground at New Freedom, Pa., where they will erect a mill for the manufacture of wire cloth.

Frank H. Mahan, of Ardmore, Pa., has been awarded the contract to build the two-story brick, stone and iron factory, at that place, for the Automobile Company, of Pittsburgh.

The Union Traction Company, Indianapolis, has let other contracts for building the subpower houses at Marion, Valesville, Fairmount, Elwood, Alexandria, Ingalls and Lawrence.

At a meeting of the E. N. Welch Clock Company, Hartford, Conn., plans were submitted and contracts awarded for a three-story structure to be completed in seventy-five days.

Plans have been completed by Guy King for a one-story brick building for the De Kosenko Manufacturing Company, Philadelphia, makers of gas fixtures. It will be used as a factory.

Henry Phipps, Jr., and John Walker, of the Carnegie Steel Company, have purchased a manufacturing site of 300 acres near the Monongahela City line, on which it is intended to erect a large steel plant at a cost of $3,000,000.

Plans are about to be started for the reconstruction of the Angora Mills building, at Sixty-first street and Baltimore avenue, Philadelphia, Pa., under the direction of Bernard Machen, president.

Sharon Steel Company, Sharon, Pa., will install 200 wire-nail machines in their plant as soon as it is completed. A machine shop is being erected, and the machines will be manufactured at home.

Several new machinists have been engaged by the Mayo Knitting Machine & Needle Company, Franklin, N. H. It is quite probable that an addition will be built to the plant to facilitate a larger production of machines.

The Coburn Trolley Track Manufacturing Company, Holyoke, Mass., is to erect a new factory in Willimansett, Mass., to cost about $45,000. Work has already begun on the foundation, and bids for the construction have been opened.

The Newton Machine Tool Works plant, at Vine street, east of Twenty-fourth street, Philadelphia, Pa., will be greatly enlarged by the erection of a brick and iron addition, two

(*Continued on page 39.*)

Wants—Continued.

recommendation or other papers of value should not be inclosed to unknown correspondents.

Situations Wanted.

Blacksmith wants position as tool-dresser. Box 197, AMERICAN MACHINIST.

Draftsman wants clerical position where tech. knowledge is necessary. Box 194, A. M.

Skilled draftsman and toolmaker wants to change. Address Box 195, AMER. MACHINIST.

Pattern-maker wants position with an up-to-date company; 5 years' experience; references given. Box 191, AMER. MACHINIST.

Wanted—Position, by practical foundry foreman; machinery or jobbing; Eastern States. Address Box 179, AMER. MACHINIST.

A first-class superintendent wishes to correspond with first-class people, to make a change. Address Box 190, AMER. MACHINIST.

Mechanical draftsman is open for position; assisting engineer or outside work preferred; 10 years' experience. Box 193, AMER. MACH.

Experienced chief draftsman and designer of tools and jigs open to engagement; good record and best of references. K. W. H., AMERICAN MACHINIST.

Situation wanted; first-class mechanical draftsman; 12 years' experience on Corliss, slide-valve engines and air compressors. Box 192, AMERICAN MACHINIST.

Mechanical draftsman, French nationality, speaking French and English, well educated, 6 years' practice in America, wants position with exhibitor at Paris exposition. Box 196, AMERICAN MACHINIST.

Position wanted as head foreman, by thorough mechanic, used to general machinery, dynamos, tools; tools designed for close interchangeable work; can handle men to best advantage. Address Box 783, Orange, N. J.

A man possessing a thorough technical knowledge of stationary engineering, with 10 years' practical experience as machinist, wants position; has complete set of tools and can do all repairs. Address Box 189, AMERICAN MACHINIST.

Toolmaker of ability and long experience on automatic screw machinery and tools will shortly be open for engagement; expert on caming labor-saving tools for anything made in rod stock; accustomed to handling men, and a cost reducer. Box 1811, Bridgeport, Conn.

A young technically educated mechanical engineer, expert in design, inspection and testing of intricate automatic machinery, wants responsible position with large manufacturing company or in engineer's office; first-class references as to character and ability; vicinity of New York preferred. Address Box 187, AMERICAN MACHINIST.

Mechanical engineer with 20 years' experience in design and construction of machine tools, steam, air and gas engines, special and automatic machinery, 5 years of which as master mechanic of large manufacturing establishment, desires to engage with good firm; New York city or vicinity preferred. Address X. Y., care AMERICAN MACHINIST.

American, 27, good education, 10 years at the trade, last 2 as foreman machinist in shop running 80 to 90 men, on marine engines and air compressors, wants responsible place with concern building air compressors and heavy engine work; want ultimate connection with commercial end of business; references. Box 188, AMERICAN MACHINIST.

American mechanic, 16 years' experience on light manufacturing, automatic machinery and special tools as practical toolmaker, foreman and superintendent, open for position April 15, or sooner if necessary; called to Germany, 1898, to equip and set in operation a plant for manufacture of automatic cashiers; work now completed; splendid recommendation from employer; speak German fluently; go anywhere. H. A. Lowe, care Al. Molineus Co., Barmen, Germany.

Help Wanted.

Wanted—First-class ship's draftsman. Address Box 198, AMERICAN MACHINIST.

Wanted—A first-class machinist for small tools and metal patterns. S. P. Townsend & Co., Bloomfield, N. J.

Wanted—At once, three good vise hands on machine tool work. Address Box 199, AMERICAN MACHINIST.

Twenty first-class machinists wanted; steady work. Address Weber Gas & Gasoline Engine Co., Kansas City, Mo.

Wanted—Young men to learn engraving by mail; send for circular. Home Engraving School, Box 1,171, Springfield, Mass.

Good machinists wanted on stationary and marine engines. Write to Box 182, AMERICAN MACHINIST, stating experience and salary wanted.

Foreman molder wanted on good machine castings in green and dry sand, to compete with the market in quality and price. N. B., 703 Beard Building, New York.

Wanted—First-class field foreman, competent to erect stand-pipes, pen-stocks, steel stacks, etc.; state wages and references. Address "Field Foreman," care AMER. MACH.

Wanted—Reliable, accurate draftsman experienced in machine-tool and jig work; state qualifications, references and wages expected. The Bickford Drill & Tool Co., Cincinnati, O.

Mechanical draftsman wanted; an experienced man on special machines and fine tool work; large manufacturing establishment near New York city. Address Box 186, AMERICAN MACHINIST.

Wanted—Several all-around machinists at Edison laboratory machine shop; sober and experienced men desirous of steady employment. Apply by letter only, to Thomas A. Edison, Orange, N. J.

Wanted—Draftsman familiar with mill design, heavy machinery, etc., about 65 miles from St. Louis, Mo.; state age, experience and salary expected. Address "Construction," care AMERICAN MACHINIST.

Wanted—In Schenectady, N. Y., a first-class draftsman and mechanical engineer to design special machinery; in applying state age, experience and salary expected. Address Box 184, AMERICAN MACHINIST.

Modern brassworker in globe valves; temperate; must give reference for ability and character; state wages desired and whether able to control men; good position to right man. "Valve," AMERICAN MACHINIST.

Wanted—Machinists who can build machinery from drawings; must be men of good habits; state experience, age, whether married or not, and give references; good pay to competent men. Box 185, AMER. MACHINIST.

We are enlarging our works, and will shortly require an increased number of skilled mechanics; we invite application from pattern makers, molders and machinists. Address the Westinghouse Machine Company, East Pittsburgh, Pa.

Wanted—An erecting man to take charge of a gang of men on automatic engines, also foundry foremen acquainted with machinery

SAVE TIME, TROUBLE AND MONEY.

When you want a reliable and competent Engineer, Superintendent or Draftsman, **write us,** stating fully the requirements of the position to be filled. . . . . .

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